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Sustainable Livelihoods and Infrastructure

Governing and configuring urban water and sanitation for reduced vulnerability in Cusco, Peru

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Date:

Abstract

This thesis argues that socio-technical systems (STS) mediate between governance and the vulnerability of households.

A STS approach enhances the analytical categories of the sustainable livelihoods framework: by conceptualising STS as the groups through which risk is shared, household risk, infrastructure and governance to be brought into a single conceptual space. The thesis develops a methodology, based on the sustainable livelihoods framework and the World Health Organisation's water system indicators, that captures the features of STS which help households to buffer vulnerability. These methods are applied to an empirical study of Cusco, Peru and three urban case studies: San Blas, near to the city's main plaza and served by the provincial water company; Angostura, a peri-urban settlement with its own water system; and Manco Capac, with a dilapidated, independent supply.

Livelihoods were vulnerable to seasonal, local and global cycles with San Blas linked to tourism; Angostura exposed to annual flooding; and Manco Capac constrained by low, seasonal incomes. Diversity and complexity in livelihoods – exposure to different risks at different times – enhanced the ability of people in San Blas and Angostura to mitigate risks, while, in more homogeneous Manco Capac, existing vulnerability was interacting with poor water, sanitation and other services to compound the risks faced by those with weak household assets. The physical hardware and institutional software of water systems contributed to differences in household vulnerability. Their modes of organisation, categorised as privileging, bypassing, resisting and networking, were driven both by governance, through policy frameworks and local institutions, and livelihoods, where socio-technical systems react to the perceived risks and returns of livelihoods and groups of livelihoods.

Sustainable livelihoods, which enhance rather than damage livelihoods of others, are undermined by bypass but bolstered where assets are complex and diverse and modes of organisation serve to network users and providers, citizens and government and contaminators and contaminated.

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Chapter 1 Water in cities

Usually whenever Owen reflected upon the gross injustices, and inhumanity of the existing social disorder, he became convinced that it could not possibly last; it was bound to fall to pieces because of its own rottenness. It was not just, it was not common sense, and therefore it could not endure. But always after one of these arguments – or, rather, disputes – with his fellow workmen, he almost relapsed into hopelessness and despondency, for then he realized how vast and how strong are the fortifications that surround the present system; the great barriers and ramparts of invincible ignorance, apathy and self-contempt, which will have to be broken down before the system of society of which they are the defences, can be swept away.

The Ragged Trousered Philanthropists, Robert Tressel, 1913

If You're an Egalitarian, How Come You're So Rich?

Gifford Lectures, G. A. Cohen, 1996

1.1 The Research Question

How do socio-technical systems mediate between governance arrangements and household infrastructure vulnerability?

The response to this question is navigated through a series of sub-questions and an empirical study of livelihoods and water and waste infrastructure in Cusco, Peru.

The sub-questions are as follows:

a) How does a socio-technical systems approach resonate and dissonate conceptually with governance and sustainable livelihoods frameworks?

b) How can one develop a methodology for understanding socio-technical systems as they mediate between governance and livelihoods in the empirical case study of Cusco?

c) What are the wider conceptual and policy implications of the empirical analysis when it is analysed through the framework developed in A and B?

1.2 Water and development: the governance challenge of delivering urban infrastructure and sustainable livelihoods

1.2.1 Global Trends in Urban Water

Water transcends political jurisdictions and spheres of governance. Its management is critical in supporting human life, sustaining agriculture and ecosystems and feeding international markets with food, flowers and fibre. In its guise as a human right or as an economic good, water is not always in the condition or place to be useful.

With more than half the world's population living in towns and cities[1], water has to be treated and distributed in a way that provides for human consumption, hygiene and industry as well as replenishing natural and artificial reservoirs, assimilating other sorts of waste and preventing the degradation of valuable ecosystems.

Some commentators suggest that thirty percent of the urban population in Latin America and the Caribbean, some 120 million people, lack adequate water with forty percent lack adequate sanitation (UN-HABITAT 2003). In addition, the evidence is increasingly showing that human development goals concerned with child health and malnutrition, currently, for example, the Millennium Development Goals, are highly correlated with the provision of what is often expensive water and sanitation infrastructure. In their 2003 World Bank paper, Leipziger et al. concluded that:

> ...this is good news because presumably it is easier to aim for universal access to water, sanitation, and electricity than for universal wealth. But it poses a daunting development challenge in the sense that the efforts required are still huge – significantly improving child health outcomes will require enormous increases in water and sanitation coverage of the poorer populations.
>
> (Leipziger 2003):14

One might legitimately ask whether the development aim of 'universal access' is in any sense *easy* given the messy governance of wealth, water, sanitation and the environment that seems to thwart it. The delivery of urban infrastructure, then, merits an altogether closer examination (Satterthwaite 2003):186.

The research question has thus emerged from the political and conceptual complexity of growing urban populations, patchy water and sanitation provision and the environmental, economic and spatial dimensions of deprivation.

1.2.2 Urban Water and An Idealistic Engineer

At the turn of the millennium, it was impossible for me to be oblivious to these trends from either a personal or professional perspective: I felt that these were the problems I was being trained to solve.

In 2001, I returned to London after a year at an elite engineering school in France, courtesy of the Cinquième Republic. That period in Paris and

[1] (UN-HABITAT & DFID 2002):4

Toulouse had been a charge into the disused wastelands of my brain: a different language, almost an art, forcing a new identity; encounters with my father's Trotskyite 'contacts' from the sixties and their cultish, clandestine political descendents; and, tasting the cosseted culture of French higher education still sired indulgently by *papa*: a clan of globalised, industrial engineers. What a mess. How could I possibly navigate my profession's 'evil dam-building ways' and lead a good and flourishing life after all that?

I responded to my confused, middle-class conscience by going 'green', reverting to the conditioning of my school days: *Blue Peter* and the ozone hole, the Rio Earth Summit, Naomi Klein's *No Logo* and burgeoning panic about climate change. I tried to make sense of it all, first by rejecting the corporate milk round, and then by joining a small-is-beautiful engineering consultancy specialising in *sustainable* master planning, building-integrated *renewables* and *zero carbon* developments. All things verdant.

Then came a chance to work on the regeneration of the Thames Gateway and develop showcase master plans for *Z-squared*: a zero carbon, zero waste development of two thousand homes. But the excitement gradually gave way to unease, prompted by a visit to a friend in Deptford. He had recently moved into a shiny, gated development: lots of glass, a concierge, a gym, a hefty service charge and a view up and over its dilapidated neighbourhood across to the city of London. I started to get nervous: would I be Frankenstein to my monstrous sustainable master plan: imposing a 'community', not just gated by CCTV and a fence, but disconnected from the pipes and wires that it might once have shared with shabbier neighbours? I worried about a strange autonomy of infrastructure where a common interest in maintenance and investment would wane and what had begun as a lifestyle choice would become self-reinforcing, technological segregation where the impacts of rising gas, electricity and water costs would be felt asymmetrically for generations. What would this mean for our right to roam the city? What is a community anyway? And what exactly were engineers helping to *sustain*? Was my notion that universal and equitable infrastructure coverage could exist in any millennial city just plain naïve?

My boss at the time had cut his teeth as a services engineer in Sweden. He loved to dazzle us with stories of students and bankers living side by side,

sharing a basement laundry room and obeying a rota. He cited Scandinavian efficiency in 'community' heating: combined heat and power distributing hot water across housing estates in insulated underground pipes. The consensus in our office was that if only the British equivalent of the sixties had not been allowed to fall into disrepair, such systems would have much to offer the fight against climate change today. At the same time, to the east, tit for tat energy disputes in the Caucuses brought newspaper stories of horrific winters in Soviet-era housing projects, where collective heating installations were jammed by rust, frozen investment and vicious price hikes. Meanwhile, ten years after the deregulation and privatisation of utilities in the UK, new infrastructure markets in Europe's accession countries were being prised open with injections of investment in offices and luxury housing in concentrated pockets of Warsaw and Riga. Venturing outside Europe, water companies from the Home Counties were taking on concessions as far afield as Dar-es-Salaam, in what was starting to describe a global trend.

All this was to the rhetorical backdrop of *decentralisation*, in both economic and environmental reportage, and *privatisation* in various guises on the international policy agenda. To my untrained eye, extrapolating from these positions seemed to lead inexorably to fragmentation: a world of privileged enclaves and excluded swathes. First, I asked myself, was this simply collateral damage in the rational pursuit of efficiency? I thought of Haussmann's Paris and the present day contrast between my very *civil* engineering counterparts at the Ecole Centrale and Mathieu Kassovitz's disturbing 1996 film *La Haine* set in the bleak and violent *banlieues* of the same city. Then I resorted to conspiracies: was it all some kind of plot? I thought of my furtive friends from *Workers' Fight* and remembered the press coverage from Seattle in 1999 – a messy anti-globalisation coalition of left, green, faithful and anarchic standing against a common enemy, the global forces of capitalism, in solidarity with its victims: ecosystems and the poor.

Water, in particular, seemed to have fuelled the polemic: it was apparently naturally free and clean, part of a common treasury, but the dastardly proposition was to buy and sell it for private gain. It caught the popular imagination with the inherent tension between its visceral incarnation as a *right* and its nature, as the Machiavellians would have it, as an economic *good*.

In conceptual terms, I was left torn between an unattainable, universal and egalitarian model of urban infrastructure and the practical delivery of hardware, guided by rational economic choices and the real cost of water. Fortunately, these positions had also been of considerable concern to policy makers, academics and development institutions long before I started to puzzle over them.

1.2.3 The Policy Response: Concepts of Governance, Vulnerability and Sustainable Livelihoods

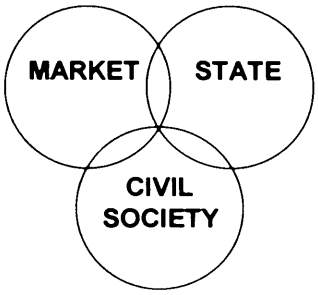
A key policy framework that emerged in response to the challenges of international development after the Cold War was that of governance. The framework addressed competing critiques of development and gave balance to a discourse that had by turns favoured governments over markets, undermined governments in favour of free trade and in both cases overlooked the importance of civil society in tackling human development and social justice.

In this scheme, the institutions and activities of the state, the market and civil society are arranged into three overlapping categories, shown in Figure 1. Such a framework can be deployed as an analytical tool for examining the activities of each set of actors and as a normative prescription for growth-promoting 'good governance'. In its normative guise the relationships between elected government, a market-oriented private sector and an amorphous civil society of citizens and non-governmental organisations are balanced, transparent and co-operative.

The framework is obviously useful since it is generic enough to be applied at various scales: at the global level, for example, to frame negotiations on international trade, security or the environment; at a national or city level in terms of participation or efforts to decentralise; and in describing the governance of water provision and the activities of parastatal companies, private investors and grass-roots movements.

The main caveat is that, just as development theorists tussle over the relative importance of state, market and civil society, so the neat balance suggested by the diagram may not reflect practical imbalances of power playing out on the ground. Indeed, as we shall see, the tidy divisions cannot always do justice to organisations that fall outside the framework (Van Rooy 2002).

Figure 1 Adapted from (Van Rooy 2002):491



In relation to urban water and waste water infrastructure, governance is an established framework through which International Financial Institutions, governments, academics and development practitioners continue to thrash out controversies and competing priorities. The World Bank's governance framework for the provision of services, for example, evolved from one that favoured privatisation in the early nineties, to, by 2004, a triangle of state, clients and service providers that closely mirrors the diagram in Fig. 1.

Meanwhile, with the reformulation of systems of governance at one end of the theoretical spectrum, at the other, Robert Chambers and others working with those on the receiving end of exclusion were calling for a more sophisticated understanding of deprivation that considered vulnerability as social, spatial and environmental:

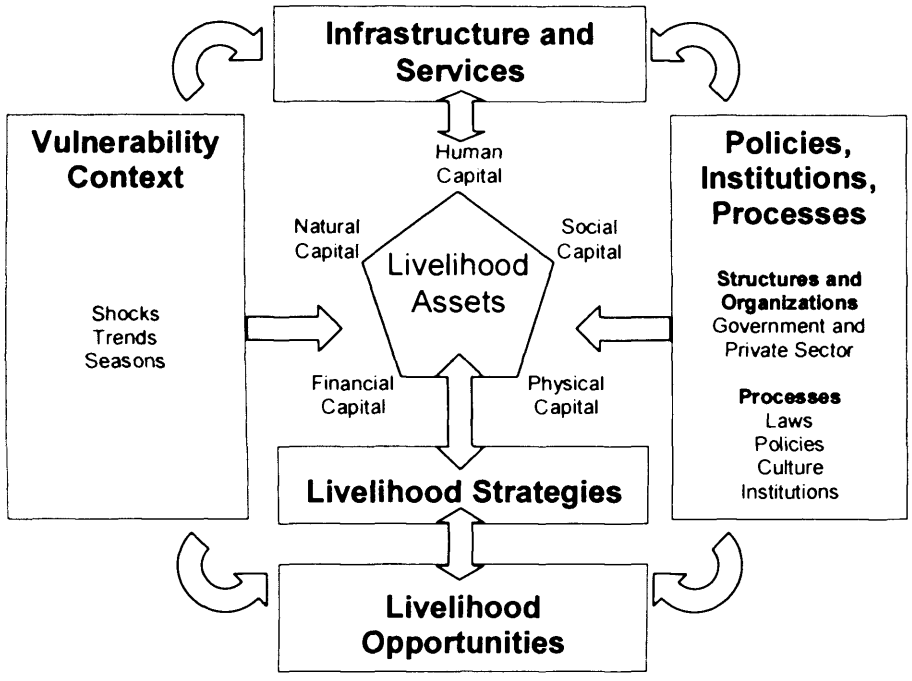
> The realities of poor people are local, complex, diverse and dynamic. Income-poverty, though important, is only one aspect of deprivation... In addition to poverty, these include social inferiority, isolation, physical weakness, vulnerability, seasonal deprivation, powerlessness and humiliation.
>
> (Chambers 1995):173

This idea formed the conceptual basis of a sustainable livelihoods model: an analytical structure for understanding the strategies of households in relation to their assets and activities. Livelihoods are understood in terms of the governance environment in which households find themselves (Policies, Institutions and Process), access to Infrastructure and Services; vulnerability to shocks and trends; and a portfolio of household assets as shown in Figure 2.

Following on from concepts of sustainable development, which aim to maintain economic, social and environmental assets to meet the needs of people now and into the future, household assets fall into similar categories of

economic (financial and physical capital), social (social and human capital) and environmental (natural capital).

Figure 2 The Sustainable Livelihoods Framework Adapted from (Rakodi 2002a)



The SL framework's underlying assumption is that whether a household can achieve a sustainable livelihood or not will depend on how well it is able to buffer and mitigate risks and shocks. By going further than the generalised Vulnerability Context, the framework not only takes account of the ability of individual households to insulate themselves against shocks using their own assets but also allows for the possibility that household risks are also buffered through collective assets like infrastructure and services as well as the institutional and policy environment in which they find themselves.

This thesis examines the role that collective infrastructure plays in mediating between systems of governance and household vulnerability.

1.3 Socio-technical systems mediating between governance and vulnerability: an empirical response to the research question

The thesis tackles the conceptual and theoretical, methodological and empirical implications of using the sustainable livelihoods framework to understand the mediating role of socio-technical systems in vulnerability.

1.3.1 Critical Interrogation of Frameworks

Despite the World Bank's optimistic rhetoric, moving from theory to implementation of new governance arrangements has been slow and problematic. The governance perspective – and certainly governance as a normative prescription – is appealing because it is easy to apply at different institutional scales and because it claims to offer pragmatism as opposed to partisan or ideological debate. In fact, the approach is often seen as part of a neo-liberal package: deceptive for appearing to take a bland, managerial approach to development while deliberately ignoring what other observers see as more adversarial social relations, vested interests and injustice.

In this connection, reviewing the state of water and sanitation in cities in 2006, Adriana Allen, Julio Dávila and Pascale Hofmann observe that:

> There now seems to be widespread agreement that in low- and middle-income countries the state alone will be unable to meet the internationally agreed targets for reducing the number of people in cities with no access to clean water and adequate sanitation. This is partly a legacy of decades of supply-led engineering approaches with high operating costs and under-utilized investment, unrealistically high standards of per capita service to formal areas of cities and a general disregard for the needs of unregulated or "illegal" urban and peri-urban settlements. Recent attempts to involve private investors in water supply have not yielded the desired results of expanding network coverage to low-income urban and peri-urban settlements, which are regarded as much less profitable than wealthier and more central areas of cities.
>
> (Allen et al. 2006):333

The authors point out that certain governance models overlook low-income and peri-urban patches of cities, prioritising the privileged rather than producing equitable or universal infrastructures.

Arguably, a governance framework with its rational and responsive trinity of actors – an atomised electorate, representative government and a market – does not have sufficient explanatory power to uncover the processes that are producing patchy distribution of infrastructure within and between jurisdictions. This is explored by Erik Swyngedouw and Nikolas Heynen who conclude that:

> ...there is no such thing as an unsustainable city in general. Rather, there are a series of urban and environmental processes that negatively affect some social groups while benefiting others. A just urban socio-environmental perspective, therefore, always needs to consider the question of who gains and who pays and to ask serious questions about the multiple power relations—and the scalar geometry of these relations—through which deeply unjust socio-environmental conditions are produced and maintained.
>
> (Swyngedouw & Heynen 2003):901

The notion that differential access to infrastructure has environmental as well as social components can be useful in situations where infrastructure and environmental assets, like rivers, weave through jurisdictions and connect groups of urban people that are not immediate spatial neighbours.

Beyond the social and environmental, the concept of Socio-Technical Systems has emerged from recent studies of globalisation, splintering urbanism and research into the links between infrastructure and sustainable household consumption. A STS approach expects an examination of the ways in which the history, institutional arrangements and spatial layout of infrastructure can embed the power relations to which Swyngedouw and Heynen refer.

The subject of entrenched biases in access has also been broached in critiques of sustainable development. Just as Swyngedouw and Heynen hint that blithe labelling of cities as sustainable or unsustainable can mask certain injustices, Robert Chambers insists that development professionals should strive to avoid practices that entrench sustainable privilege for 'us' rather than sustainable well-being for 'them' (Chambers 1995)204. Building on the empirical, participatory heritage of the SL approach, Chambers' also applies this thinking to sustainability in the context of livelihoods and argues for the interdependence of livelihoods with the channels connecting 'us' to 'them' seen as both physical and institutional or social and technical:

> *...a sustainable livelihood should not damage but enhance the livelihoods of others (whether through claims, access, international trade, environmental effects or in other ways) now and/or in the future.*
>
> (Chambers 2005):202

This brief summary has built on a critical interrogation of the governance, SL and STS frameworks and it leads to the following propositions. Firstly, the SL framework recognises that vulnerability – or the inability of households to buffer the risks that destabilise their livelihoods – is not just a fleeting function of deprivation. It acknowledges the powerful influence of governance in terms of policies, institutions and processes, and it conceptualises the role of

infrastructure in terms of household access to services at a certain moment and in a certain place. From here, the framework cannot get any closer to an analysis of how vulnerability is embedded through infrastructure systems which, on one hand, present differential risks (and vulnerability) to households and, on the other, are shaped by high level governance prescriptions which can result in processes that privilege and bypass certain groups.

Secondly, although a governance framework can go some way towards untangling the institutional factors which link livelihoods together, it is deliberately blind to the inherent power imbalances that shape the negotiated and incremental development which might enhance or damage livelihoods.

Thirdly, a STS approach serves as a useful conceptual bridge between vulnerability and governance. The framework developed in Chapter 2 deals with a) the political blandness of the governance framework, b) the importance of the spatial and collective arrangements of urban infrastructure that are missing from the livelihoods framework, c) examines urban risk-sharing beyond vague assumptions about urban "communities" that are implied by the governance frameworks conceptions of civil society and the livelihoods conceptions of social capital.

1.3.2 Formulation of an interdisciplinary methodology

Despite the limitations of a governance lens, it remains a useful way to link critiques of development and navigate the sometimes messy patterns of urban governance. In this research, it frames an analysis of historical accounts, water sector reports and primary interview data and is used to identify the important players and events in the Peruvian context.

The analytical categories offered by the livelihoods framework have shaped the research design from the use of case studies and the structure of household and key informant interviews through to the analysis of secondary data. This methodology encourages an analysis that understands the links between the livelihoods of the best and worst off and, since in parts of Cusco the juxtaposition of privileged and poor is superimposed onto a common, proximate stake in such things as water supply infrastructure, this research is based on three case studies which take in a variety of the household strategies and vulnerabilities at play in the city.

The STS concept is used to unpick the qualitative and quantitative aspects of water and sanitation infrastructure that affect household vulnerability. Three socio-technical indicators are invoked for this purpose: the socio-technical scale of the water system, the performance of the water system and the quality of the household connection to the system.

Socio-technical scale describes the system's links into the environment: to water sources, pollution sinks, energy resources or other infrastructure networks. At the same time, it looks at the number of users, the geographical extent of the system and the wider social and technical systems into which infrastructure can tap. In this way, the socio-technical scale of a small, independent peri-urban piped water supply may not be limited to just its users but networked to support from international NGOs, local government, training from the municipal water company and equipment sourced from a great distance.

System performance is understood in terms of water quality, water quantity and the continuity, accessibility and affordability of the water service. Evaluating this performance is based on the World Health Organisation's guidelines for assessing sanitary risk and the institutions with responsibility for the system.

Household connections obviously depend on the performance of the system to which they are able to connect themselves but also on the condition of household taps, patio drainage, domestic water treatment and hygiene practices. In addition, when water runs out, households may have recourse to alternative sources from less profligate neighbours, relatives in other places, local markets or other institutions. These interactions are understood as part of the lived experience of infrastructure and are assembled through the sustainable livelihoods framework.

1.3.3 Case Studies, Data Acquisition and Processing of Empirical Data

Where better to look for answers to questions about urban infrastructure than the continent famous for its *barrios cerrados*, its cities made legendary by their disparities of wealth and, more recently, the nexus of closely watched struggles over water privatisation in Bolivia, Argentina and Chile. In this connection, Peru is particularly interesting because, although the country

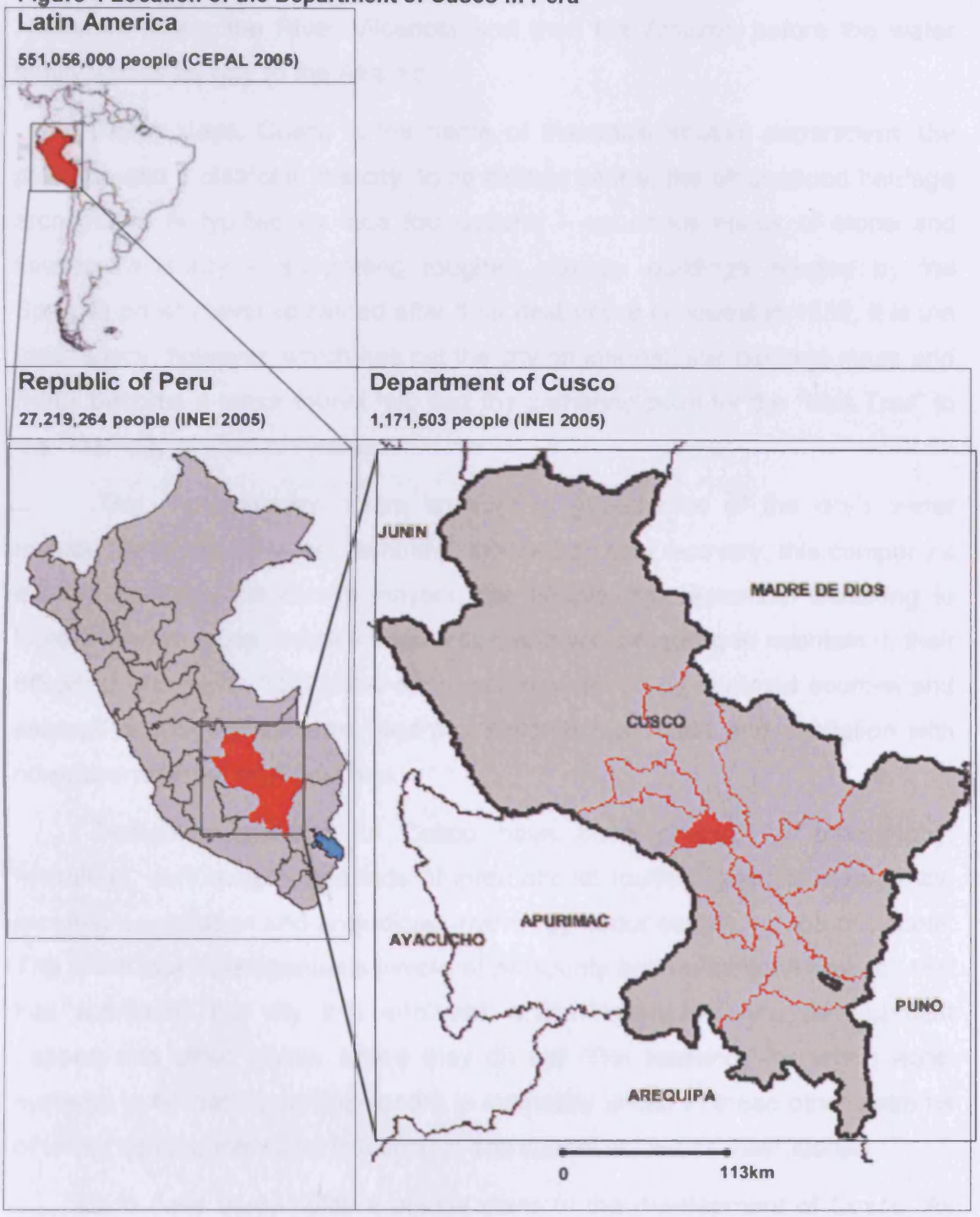
experienced several important regional shocks and trends during the eighties and nineties including a debt crisis, violent civil unrest and political turmoil that gave rise to a partial rollout of decentralisation, Peruvian reform of governance in the water sector, at least until now, has seen a move towards commercialisation of parastatal companies rather than privatisation.

Peru is the third largest country in Latin America, covering some 1.3 million square kilometres and taking in the lush, Amazon basin to the east (la selva), rising over the spectacular Andean mountain range running north to south (la sierra) to its flat, arid coastal strip bordering the pacific (la costa) (Figure 2). The population, recorded by the 2005 census at just over 27million people, is multilingual and multiethnic and is still economically polarised by a concentration of prosperity in the coastal region around the capital, Lima, and incredible poverty in its mountainous hinterland.

Figure 3 Latin America with Peru highlighted

Peruvian political traditions of authoritarian rule from the centre, populism in the regions and disparities of wealth along geographic lines have fomented an intense rivalry between Lima and important regional cities. In 1992, finally acknowledging its cultural significance, Peru's colonial and modern capital Lima granted the city of Cusco, perched 3,300m above sea level in the Andes, the title of "historic capital".

Figure 4 Location of the Department of Cusco in Peru



To the Inca, the name Cusco meant navel: the city was the central focus of their empire and was of strong spiritual and strategic importance (Figure 3). Surrounded by craggy peaks, Cusco nestles at the head of the *Valle Sur,* or Southern Valley, which gradually spreads into a broad, fertile flood plain as it descends from the city. On the valley floor is the River Huatanay, the main watercourse, fed by springs and the violent, seasonal surface water which charges down from the micro-catchments on either side. Eventually, the Huatanay meets the River Vilcanota and then the Amazon before the water finally wends its way to the Atlantic.

These days, Cusco is the name of the administrative department, the province and a district in the city. In its historic centre, the oft snapped heritage architecture is typified by Inca foundations – enormous hunks of stone and flawless masonry – supporting rougher, colonial buildings erected by the Spanish on whatever remained after their destructive conquest in 1532. It is the Inca legacy, however, which has put the city on international heritage maps and it has become a major tourist hub and the gathering point for the "Inca Trail" to the "lost" city of Machu Picchu.

The contemporary actors enrolled in governance of the city's water include the provincial water company, focused on cost recovery; this company's elected masters, the district mayors; the people that remember sweating to build their own independent infrastructure and are struggling to maintain it; their offspring who suffer from water shortages brought on by depleted sources and decrepit distribution systems; and those working on water and sanitation with non-governmental organisations.

Settlement patterns in Cusco have been shaped by topography, hydrology, earthquakes, the fads of international tourists, guerrilla insurgency, property speculation and prejudiced mythology about certain groups of people. The result is a heterogeneous jumble of prosperity and hardship, a process that has splintered the city into enclaves where investment and development happen and other places where they do not. The tendency for urban water systems to be patchy or fragmented is intimately linked to these other patterns of urban development and is technical and spatial as well as institutional.

Each case study holds a unique place in the development of Cusco. As the city has spilled down into the valley, Angostura, once a rural settlement, has

found itself on the edge of town while Manco Capac, close to the centre, is yet to be incorporated into the provincial water system. In the historic centre, for example, San Blas has only recently seen its colonial era stone drains replaced and connected to provincial system.

In each location, "best off", "worst off" and "typical" households were identified with local gatekeepers and key informants, household interviews were conducted and water samples were taken in the rainy season and dry season. Interviews were conducted with key informants in local government and water provider organisations. The water systems in each location were evaluated with key informants and water samples taken at source, storage and treatment. Participatory exercises were also organised with the householders and gate keepers.

Data was analysed through the categories of the livelihoods framework and the qualitative and quantitative indicators offered by the World Health Organisation for evaluating water systems.

1.3.4 Comparative Analysis, obtaining key indicators and drawing conclusions

The role played by STS in mediating between governance and vulnerability in each case study is understood through a comparative analysis of the livelihoods and STS in each location. This leads in to a wider analysis of the ways in which the policies, processes and institutions of governance in Cusco influence and are influenced by livelihood vulnerability across the city. These patterns are then explored using the conceptual framework developed early on in the thesis to map the relationship between governance, livelihoods and infrastructure.

The key indicators in the study relate to household vulnerability, water and sanitation infrastructure and institutions of governance. In terms of household vulnerability, I use livelihood assets, presented along five axes of human, social, physical, financial and natural capital, a thematic analysis of livelihood strategies and sanitary risk scores in each household. Sanitary risk scores are a composite indicator of the presence of faecal contamination and a visual inspection of sanitary risks. Livelihoods are understood as diverse – stretching

to take in different activities and locations – and complex – connecting to hubs of resources, knowledge and capacity.

Water and sanitation infrastructure is evaluated using the quality, quantity, continuity, accessibility and affordability indicators established by the World Health Organisation. In addition to these, I explore each system's socio-technical mode of organisation as a function of engagement with other entities in the governance framework including providers, municipal authorities, NGOs and communities; the number of users; the rate of drinking water production and; the spatial extent of the system. Systems are then classified as modes that privilege, bypass, resist or network.

Using these indicators, I argue that households face risks to their livelihoods that are differentiated by their access to assets, infrastructure and influence. Modes of organisation of water and sanitation infrastructure are a response to the governance imperatives of providers and their perceptions of livelihoods but they also tend to interact with household vulnerability to amplify risk for those least able to buffer it. The potential for urban households to mitigate risk in a sustainable way is undermined by bypass, weak assets and homogeneity in livelihood strategies. This potential is enhanced where assets are strong or livelihood strategies are mixed but also where socio-technical infrastructures create complex and diverse networks of people, knowledge, assets and institutions that link powerful and vulnerable livelihoods.

1.4 Mapping the thesis: structuring the argument

The research question has been tackled in four parts beginning, in Chapter 2, with a critique of sustainable livelihoods and the ways in which this framework understands governance, infrastructure and livelihoods. This critique then goes forward by introducing and developing concepts that help to illustrate the mediating role played by infrastructure in household vulnerability. This answers the first sub-question.

Next, in Chapter 3, the thesis argues for a research methodology and a set of tools that allow governance, livelihoods and socio-technical systems to be evaluated on the ground. This offers qualitative and quantitative methods, visual and graphical tools and the use of case studies for analysis of results from an empirical study in Cusco. This answers the second sub-question.

The third part of the document is a presentation of the data collected in Cusco. This begins with an introduction to Peruvian governance and infrastructure, in Chapter 4, and is followed by three chapters describing the livelihoods in three urban case studies: Chapters 5, 6 and 7. These descriptions follow the analytical categories set out by the livelihoods framework and set the scene for responding to the research question by describing the links between household assets, strategy and vulnerability in an urban context.

The fourth part of the thesis uses the foregoing analysis to answer the research question. In Chapter 8, I bring together the livelihoods analysis and a socio-technical analysis of the infrastructure in each case study to argue that household vulnerability is mediated by socio-technical systems. This part of the thesis is then concluded in Chapter 9 with a broader view of the relationship between socio-technical systems and governance in Cusco. This chapter argues that socio-technical systems mediate vulnerability because they become configured as modes of organisation that either allow households to buffer risk or that leave households more exposed. These modes of organization act to privilege, bypass, resist splintering and network and they are driven by governance, governance of provision and a series of reactions to the reality of or assumptions about livelihood vulnerability.

The document concludes by answering the third sub-question, by summing up and outlining the contribution and implications of the research.

Chapter 2 Unwrapping the research question: a critical interrogation of the frameworks

The core aim of this thesis is an exploration of household vulnerability and its relationship with governance; a relationship which I hypothesise is mediated through infrastructure. In arguing for this relationship, I respond to the first sub-question posed in Chapter 1 and examine the conceptual ways in which a socio-technical systems approach resonates with each component of the sustainable livelihoods framework.

This chapter begins, in Section 1.1, with an introduction to Sustainable Livelihoods (SL), a framework which has already brought together concepts of vulnerability, infrastructure and governance. This framework is also, fundamentally, a manifesto for participatory development that is focused on the activities of households and communities.

Notwithstanding this participatory emphasis, development practitioners have been quick to warn that, while involving the least powerful is critical to understanding and mitigating vulnerability, this activity should not be to the exclusion of a critique of governance. With this in mind, Section 1.2 moves immediately to the context of development and a critical examination of the twin shifts in theoretical and political attitudes to the state, the market and civil society.

Section 1.3 then offers a critical analysis of the governance discourse applied to infrastructure provision and the difficulty in handling within a governance framework the anomalies of non-homogeneous urban infrastructure. This section concludes by arguing for a perspective that understands the social and technical dimensions of infrastructure.

In Section 1.4, I argue for socio-technical systems as a useful conceptual bridge between household vulnerability and governance. The first stage of this argument relates infrastructure and governance. By building on studies of cities and globalisation, splintering urbanism and the role played by local institutions, the STS approach is shown to offer an enhanced set of concepts for understanding the mediating role that infrastructure plays in shaping cities and services. The second step is to demonstrate that the relationship between household livelihoods and infrastructure is usefully described by categorising socio-technical systems by their modes of production and consumption.

Finally, in Section 1.5, I return to the SL framework for a closer look at vulnerability, arguing that household assets and collective infrastructure are

intimately linked to each other and to vulnerability. This critique then allows me to introduce my framework for understanding vulnerability and governance in terms of the collective sharing of risk through infrastructure.

2.1 Sustainable Livelihoods: an analytical framework linking vulnerability, infrastructure and governance

> *How much should a rational plan of life allow for elements such as friendship, love, political activity, attachments to property or possessions, all of which, being themselves vulnerable, make the person who stakes his or her good to them similarly open to chance?*
>
> *The Fragility of Goodness, Martha Nussbaum*

The sustainable livelihoods [2] (SL) framework [3] builds on participatory approaches to development and first emerged as an analytical framework for understanding rural livelihoods in the late nineties (Scoones 1998). The need for participation was recognised by Robert Chambers in his work *Whose Reality Counts?* (Chambers 1997) in which he argued that the world's unequal power relationships are replicated in bureaucracies and systems which exclude local people and local knowledge. His plea was that we move away from ideas of better planning and integration, towards a vocabulary that emphasises civil society, governance, livelihoods and sustainability[4].

The basis of the SL framework is that households manage a range of assets in a context of vulnerability and in response to a set of policies, institutions and processes. In Section 2.5, I will examine assets and vulnerability in more detail but at this stage it is sufficient to understand that maintenance of these assets is based on the concept of sustainable development – formulated twenty-years ago by the Bruntland Commission – and the oft cited statement that development ought to meet "the needs of the present without compromising

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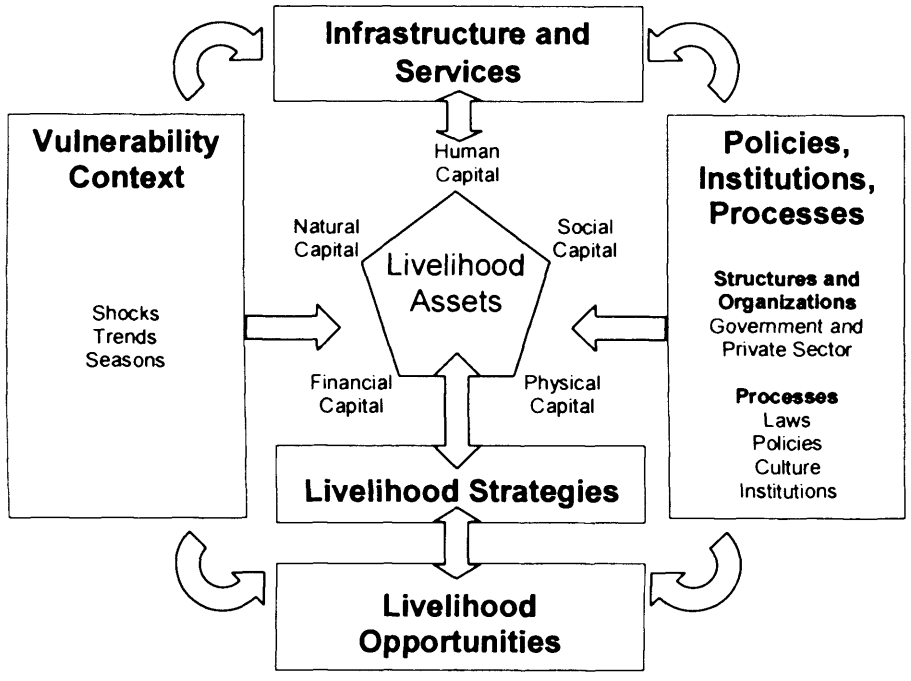
[2] Early use of this can be found in the 1995 Copenhagen Declaration on Social Development (http://www.un.org/esa/socdev/wssd/index.html).

[3] Also promoted by the UK Department for International Development (DFID 1999)

[4] His stance is that in a highly polarised world, as the educated elites and specialists become 'modernized', they are drawn from periphery to core, from rural to urban and their power becomes concentrated in places far away from the peripheries. Their collective reaction is then to try to standardise indicators and tools to allow comparisons and performance to be monitored from a distance. Chambers proposes a shift from conventional epistemologies to the idea that there are multiple and complementary types of knowledge and that we must adopt holistic, participatory methodologies in order to unearth reality (Chambers 1997).

the ability of future generations to meet their own needs." [5] (World Commission on Environment and Development 1987):43. The version of the framework shown in Figure 11 is adapted from Tony Lloyd-Jones' diagram in work on urban livelihoods edited with Carole Rakodi.

Figure 5 Sustainable Livelihoods Framework



Just as confusion has raged over how sustainable development might meet the unknown "needs of future generations" [6], so there are different interpretations of a sustainable livelihood. In its most demanding incarnation, a sustainable livelihood is explained by Robert Chambers as a way of life that:

> ...should not damage but enhance the livelihoods of others (whether through claims, access, international trade, environmental effects or in other ways) now and/or in the future. This, of course, applies most to the rich and powerful, to their lifestyles, and to their impacts both on the livelihoods of others and on the environment through pollution, climate change and resource depletion. A worldwide campaign for awareness and abstinence was implied....The concept of sustainable livelihoods has, however, been applied selectively only to the poor. As with so much of development research, discourse and action, the searchlight is not directed at 'us'. 'We' so not have to look at ourselves, only at 'them': those whom we seek to do good to, help and empower.
>
> (Chambers 2005):202

[5] A politically palatable a scheme in which social development and environmental stewardship are compatible with economic growth (Haughton 1999):64.

[6] Future generations have "*unknowable lifestyles (livelihoods and consumption patterns).*" (Woodhouse):159. Hardoy et al. point out that sustainability is regularly understood as a byword for long-term financial viability[6] and that such a broad definition risks sustaining the status quo in the social, political or economic arenas and are not in the spirit of change that these authors would like to see (Hardoy et al. 2001):353.

The interconnection that Robert Chambers sees between the livelihoods of groups, that he essentially polarises in much of his writing into the powerful and the disempowered, is of particular importance with respect to shared and geographically stretched resources such as infrastructure and ecosystems. This importance is expressed clearly by de Haan et al. in their analysis of methods for understanding urban poverty:

> Contextual factors place the household and community into a situated perspective. Chiefly it is factors around governance, government and policies; markets and macro-economic linkages; and civil society and broader support networks that are analysed – the 'policies, institutions and processes' which mediate access to the resources and assets required to sustain a livelihood.
>
> (de Haan et al. 2002):4

Similarly, Carole Rakodi, in her work on urban livelihoods, recognises that using households as the unit of analysis may mean a neglect of policy, governance and other macro and structural factors reinforcing "unequal access to and control over resources" (Rakodi 2002b):293. In David Satterthwaite's contribution to Rakodi's collection of essays on urban livelihoods, he makes this point forcefully, noting that "the most powerful policies" which affect the urban poor are "national economic and social policies" (Satherthwaite 2002):256. Farrington et. al. go so far as to assert that urban livelihoods are in fact "[m]ore vulnerable to 'bad' governance" than their rural[7] counterparts (Farrington et al. 2002):8.

Building sustainable urban livelihoods goes beyond the household, through various infrastructures and environmental resources to spheres of governance[8] and it is with this concept that I begin the argument for socio-technical systems as an enhanced way of understanding the mediating between governance and livelihoods.

2.2 Governance: policies, institutions and processes

I wanna be the leader
I wanna be the leader

---

[7] The urban-rural divide is more recently understood as a continuum (Rakodi 2002b;UN-HABITAT & DFID 2002).

[8] "sustainable development is about developing systems of governance" that ensure "the needs of city dwellers are met while keeping to a minimum the environmental costs passed on by city-dwellers' consumption and city-based enterprises' production to other people, other ecosystems and global 'life-support' cycles, both now and into the future."(Hardoy et al. 2001):338.

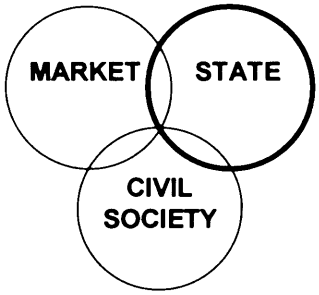
Can I be the leader?
Can I? I can?
Promise? Promise?
Yippee I'm the leader
I'm the leader

OK what shall we do?

The Leader, Roger McGough

A governance framework usually refers to an analysis of three important groups of actors in development: the state, the market and civil society. To uncover what this analysis can overlook, it is important to look at its origins and the historical shifts towards greater emphasis on one or other of these groups of actors. This section looks at each in turn, beginning with the state and then moving to the market and civil society.

2.2.1 Development and the State



Mainstream views on the role of the state tend to respond to the prevailing political and economic mood. As John Martinussen explains, the need for economic recovery in Western Europe and the USA after World War II spurred a move away from the classical focus on short-term, market equilibrium and comparative advantage and towards a distinction between economic growth as a naturally occurring cure-all and "development as a structural transformation process" (Martinussen 1997):50. Theorists came to the view that:

> [the economy] consists of hard, specific pieces of capital goods and individuals trained in specific skills and located in specific areas...[it] cannot easily be changed just through the accumulation of capital and growth in production and consumption
>
> (Martinussen 1997):51

Although the emphasis here is on the structures which might inhibit growth, the modernist view maintained that, with the odd structural tweak, all nations

could develop on a similar trajectory towards homogenous modern[9], rational and orderly societies and economies, as opposed to their more untidy, traditional arrangements.

During the nineteen-fifties and sixties, observing that inequality between countries was not automatically resolved by international trade as theories of comparative advantage predicted[10], important theoretical advances were made in Latin America. Colin Clarke, writing on *The Latin American Structuralists*, splits the ideas that emerged into theories of *structuralism (*industrial versus agrarian structures), *marginality* (capital-intensive industrialization and the social groups it marginalized), *internal colonialism* (metropolis-satellite domestic relationships) and *dependency* which articulated a world of peripheral developing nations that depended on core industrialised states wherein:

> developed countries had an endogenous capacity for growth and were dominant, while underdeveloped countries lacked that dynamic and were dependent on foreign investment and technology.
>
> (Clarke 2002):94

For developing countries, an early strategic implication of these theories was to disconnect themselves from industrialized nations and rely on state intervention to drive domestic industrialization and co-ordinate self-reinforcing growth (Martinussen 1997).

The structuralists brought attention to polarized patterns of development but faced a challenge over the function of nation states and whether these entities were bureaucratically and politically capable of tackling this polarization. In this connection, Peter Evans argues that one should not assume that just "because the state is necessary it will therefore have the inclination and capacity to fill the required role" (Evans 1985):46. Ultimately, for Evans, governments should only do what they are good at doing.

This view leaves open the question of what the state might be 'good' at but economists of the early seventies began to wonder whether governments

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[9] Classical modernisation theory (1940s and 50s) presented social development as the gradual replacement of traditional social phenomena by the modern. Economic theory characterised modernisation as the appearance of economic artefacts: division of labour, specialisation, high productivity, industrialisation and growth. Political artefacts included elites, a benign and active state, democratic government and equality before the law.

[10] After World War II, industrialised countries did not pass on gains of hosting the most advantageous, highly productive industries to less developed countries through investment and trade. Instead, prices of raw materials fell relative to manufactured goods: productivity gains were absorbed by industrialised countries (Martinussen 1997)

were 'good' at anything: particularly at managing an economy. David Simon, writing on "Neo-liberalism, Structural Adjustment and Poverty Reduction Strategies", notes that:

> Profound disillusionment in the North with the record of state involvement in economic and social life led to a simplistic and rather naïve belief in the 'magic of the market' as the most efficient economic regulator.
>
> (Simon 2002):87

For Latin America, this Northern disillusionment, borne out of rising fuel prices and a cycle of recession, laid the foundations for a debt crisis that would cripple the region's economies for at least a decade. In 1973 oil prices spiked and inflated oil revenues were deposited in US banks. These banks were eager to lend to developing countries, which were at that time willing and able to pay interest premiums[11]. Latin American governments increased their borrowing, enthusiastically backing loans taken out by their domestic private sectors. Meanwhile, in oil-importing developed countries, oil price rises were fuelling inflation. Governments responded by raising interest rates to restrict the supply of money and this in turn triggered a worldwide slump as northern consumption slowed and the markets for goods from developing countries contracted (Corbridge 2002):478.

These events gave succour to the creeping popular dominance of neo-liberal ideas and the demise of state-led attempts at economic transformation. Colin Clarke, although he observes that neo-liberalism took another decade to take root in Latin America, concludes that:

> These variegated structuralist approaches by Latin American social scientists have been marginalized by the hegemony of the economic orthodoxy emanating from the World Bank since the 1970s...
>
> (Clarke 2002):94

There remain differences in opinion over the extent to which the state should intervene in procurement, regulation and production but, as an example of one such World Bank 'emanation', the bank's analysis of *The State in a Changing World* frames the state as:

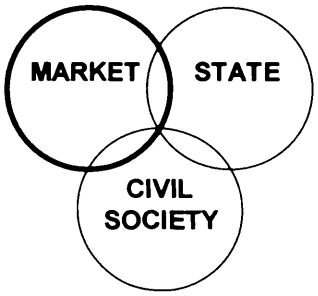
> ...central to economic and social development, not as a direct provider of growth but as a partner, catalyst, and facilitator.

[11] 2% more than US government bonds

(World Bank 1997):1

In summary, despite being in thrall to the powerful interests of Northern consumers, governments and International Financial Institutions (IFIs), the state became the scapegoat for various economic crises of the late seventies and early eighties. This carved out space for the idea that the role of the state should be qualified by its own internal competence and legitimacy.

2.2.2 Development and Free Markets



With the state out of favour, neo-liberal development thinking took hold. Its twin assumptions are that economic growth *is* development and, given this, that an unfettered market offers the most efficient mechanism for allocating goods and services as economies grow. Free markets were seen as the antidote to inept economic meddling by governments, taking on particular momentum at the University of Chicago.

For Peru and the rest of Latin America, 1982 was a landmark year: Mexico defaulted on its mounting debt and became the first of many countries forced to adopt the IMF and World Bank's favoured two stage liberalisation package of *stabilisation* followed by *structural adjustment*. In the short-term, domestic currencies had to be devalued to allow export expansion and with this came complementary measures to control inflation by cutting social spending and shelving public investment projects. This had a particularly crippling impact on education, health and nutrition programmes (Simon 2002):88.

The regional effect of prioritising exports in the short-term and running down infrastructure, otherwise so important to productivity, tended to be that longer term export growth was stymied by poor transport, communications, energy and water systems. Governments were no longer able to muster

revenue and polices that favoured inward investment had to be relinquished, opening the way for investment to be farmed out to the international private sector (Flindell Klaren 2000).

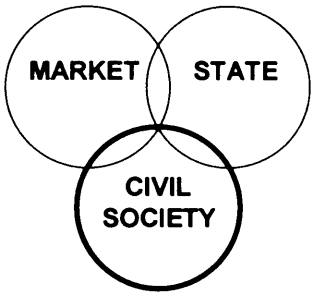
Meanwhile on the global stage, as Bjorn Hettne points out, after a decade of neo-liberal reforms driven by the International Financial Institutions (IFIs), it was convenient in the early 1990s to attribute any remaining 'development problems' to "'rent-seeking' bureaucrats and corrupt politicians, with no blame at all put on the 'world system'" (Hettne 2002):8. On this basis, the IFIs were able to conclude in their 'Washington Consensus' that the only obstacle to development was political reform[12] which favoured "liberal market capitalism" and "liberal democracy" (Potter 2000):375. An important policy implication of the push for 'good governance' was that financial aid from IFIs and rich governments, which formerly had been subject to the economic conditionality of structural adjustment, would now also be wrapped up in "political conditionality" (Jenkins 2002):487.

Criticism of the painful social consequences of structural adjustment presaged a fresh emphasis on 'governance', as distinct from 'government'. It prompted a new interest in a functioning civil society as a counterweight to both state and market.

The governance framework thus gained institutional and linguistic momentum in part because it was both compatible with the neo-liberal agenda and appealing to some of this agenda's dissenters. Although those measuring economic growth still point to the positive influence of liberalisation in the aggregate, the jarring impact of neo-liberal policies on the poor did led to a re-examination of economic reform and calls for checks and balances by government and civil society. Civil society is the final element of the governance framework.

[12] Using the example of Nigeria, Paul Collier argues in *The Bottom Billion* (Collier 2007) that economic reforms imposed at the onset of the debt crisis are wrongly associated with economic hardship and they actually maintained growth in the face of a recession that would have happened anyway but, in the popular consciousness, the government responsible for economic reform remains associated with economic collapse.

2.2.3 Development and Civil Society



In his influential work *Development as Freedom,* Amartya Sen argues that development is more than economic growth, more than economic transformation and more than access to ideally functioning markets. Instead, he inverts the relationship: rather than extrapolating from these three economic concepts to explain the shape of social life, he argues that these three are manifestations of another aspect of development which he calls freedom:

> ...in the context of narrower views of development in terms of [Gross National Product] growth or industrialization, it is often asked whether certain political or social freedoms, such as the liberty of political participation and dissent, or opportunities to receive basic education, are or are not "conducive to development." In the light of the more foundational view of development as freedom, this way of posing the question tends to miss the important understanding that these substantive freedoms...are among the constituent components of development. Their relevance for development does not have to be freshly established through their indirect contribution to the growth of GNP or the promotion of industrialization. As it happens, these freedoms and rights are also very effective in contributing to economic progress...
>
> (Sen 1999):5

With Sen's 'freedom' seen as a metric of development that challenges the status quo, the somewhat more compromising and less radical concept of civil society has gained ground. Two aspects of civil society are useful to throw light on the Peruvian case in Chapter 4: non-government organisations and notions of participation.

2.2.3.1 Non-governmental organisations: representation, constitution and legitimacy

Alan Fowler's analysis of non-governmental development organizations (NGDOs) in the Latin American context shows the diversity of such a category:

> NGDOs in Latin America have early origins in alliance with unions, peasant associations, popular movements and their responses to military dictatorship. They were often protected by links to the Catholic Church and informed by radical theology. At the same time, military régimes created their own NGDOs to show that they had a 'human face'. This intentionally complicated the NGDO

> landscape. In this era, much NGDO finance came from private sources in the North. Later NGDO evolution has capitalized on the space created by the inauguration of civilian régimes and democratic governance. Their growth was, until recently, further spurred by aid flows designed to 'consolidate democracy' and by including NGDOs in development initiatives, such as 'social funds' intended to mitigate the social costs of structural adjustment programmes.
>
> (Fowler 2000):8

Jenkins sounds a similar cautionary note when he identifies a gap between the idealistic, theoretical construction of civil society and its slippery reality:

> By seeking to recreate a badly flawed vision of how 'functional' civil societies in the West actually operate – or, even worse, operated at an earlier stage in their developmental trajectories – both social theorists and development practitioners have betrayed an instinctive reluctance to face up to civil society's inherently precarious condition and sometimes ugly character, or to let democracy do its unpredictable work.
>
> (Jenkins 2002):488

Despite the pitfalls of assuming that non-governmental organisations are benign, neutral or incorruptible, the presence of NGOs is still considered an important indicator of an active civil society. Vandana Desai, for example, offers an optimistic view of the normative role played by civil society in terms of both the representation of citizens and scrutiny of government when she correlates more numerous civic actors with opportunities for voice, autonomous regulation of the state and networked alliances to pressure the state (Desai 2002):497. Her assumption is that civil society is more effective when it builds as many organisations as possible.

Turning to Jenny Pearce's reflections on the position of big international non-governmental organisations vis-à-vis the state and the market, a bland 'bums-on-seats' view of civil society rather overlooks the changed role of NGOs. Pearce argues that various pressures have pushed NGOs away from social development when she surmises that:

> Indeed, it might be said that 20 years of economic liberalisation have damaged the NGO sector, fragmenting it and fomenting competition in which, as the free-market model argues, only the most effective survive. The rush to efficiency, as if it were a discrete and neutral outcome of technical decisions, appears to have been at the cost of the time-consuming and messy business of debating other values, such as how greater efficiency could be pursued without a cost to social-change objectives.
>
> (Pearce 2000):23

To make matters more complex, John Clark grappling with the issue of NGO legitimacy notes that it is bound up in mass membership and spending power but also in the "usefulness" of NGOs to the public, the media and parliamentarians (Clark 2002):505. On this view 'voice' is channelled through organisations that are not only constituted by individual citizens but also by other layers of congealed interests, a symbiosis which Clark sees as positive in a democratic context but which highlights ambiguities in the motivation and function of NGOs.

As we shall see, in the debate over service delivery, NGOs are considered legitimate service providers where markets and governments are failing to deliver and, if we are to accept the case of Fowler and Pearce that the neo-liberal agenda has forced NGOs to pick up service provision at the expensive of addressing social change, then we start to see the argument that a heavy push for what might be seen as an 'apolitical' governance framework is indeed the perfect complement to neo-liberalism.

2.2.3.2 Decentralisation: globalisation and local participation

The normative 'good governance' agenda takes liberal democracy as its reference point with legitimacy bestowed on government through citizen participation in elections. Bjorn Hettne, raising the issue of the state's legitimacy, identifies a tendency for the state to become alienated from civil society as globalisation encourages it to roll back or "unbundle" its traditional functions (Hettne 2002):10. Adding to this at a national level, Nick Devas notes that adversarial relationships between central and local tiers of government have not just alienated civil society but have undermined local authorities (Devas 2005):353.

In response, proponents of good governance have promoted the decentralization of national *administration* and, less often, the devolution of national *power* to regional and local authorities. Similarly, advocates of sustainable development produced Local Agenda 21 (UNCED 1993) a document which sought the renewal of democracy "*through an increased stress on participation*" (Pelling 2002):288.

The archetypal, neo-liberal attitude to decentralization is highly optimistic with Montgomery et. al., painting a picture of market efficiency in local government:

> In decentralized systems, local governments acquire a stake in local economic prosperity. They can arrange the menu of local public goods to suit local preferences, although the quantities supplied will be constrained by local revenue-raising capacities and transfers from other levels of government. In such systems, local consumers can express their preferences for bundles of public goods by voting or moving to other jurisdictions. Under ideal conditions, local politics can then achieve something of the efficiency of markets.
>
> *(Montgomery et al. 2004):65*

In its most benign incarnation, then, the political motivation for re-structuring a centralized state is to improve the access of citizens to decision-making processes. In practice, of course, Bjorn Hettne's "alienation" can manifest itself in anything from an unwillingness to pay tax to separatist violence and it is often these fiscal and strategic concerns that drive re-structuring.

Decentralized government is also subject to Evans' caveats in his analysis of the state's competence (or lack thereof): if local governments do not have the technical capacity to devise appropriate regulation or mobilise finance, local configurations of power may be just as exclusive as national ones (Evans 1985). In this connection, John Farrington, Tamsin Ramasut and Julian Walker claim that what follows from undermining these intermediate institutions is the inability of local governments to include or reach the poor.

Diana Mitlin also suggests that participation has sometimes been "welcomed as a new opportunity for cost recovery" (Mitlin 2001):152 by the private sector and, as we will see in Cusco's Santiago District, by the public sector. Farrington et al. also make this point, concluding that participation is:

> ...linked both to democracy for its own sake and to state attempts to devolve responsibility to the poor to pay for their own infrastructure and services.
>
> (Farrington et al. 2002):32

Pointing to the twin dynamics of domestic decentralization and global integration, Richard Batley (Batley 1997):343, Anthony McGrew (McGrew 2000):352 and Farrington et al. are all concerned with the delicate balancing act between giving people the power to make decisions locally and leaving them to fend for themselves in a globalized world. In his essay on participatory development, Giles Mohan notes that these issues cannot be overlooked in an analysis of local development:

> ...many processes affecting their (or our own) lives are often not readily tackled

> at the local level...The emphasis on grassroots civil society can leave important structures untouched and do nothing to strengthen states and make them more effective and accountable to their citizens.
>
> (Mohan 2002):53

As we shall see in Chapter 4, applying the terminology of decentralisation and participation to the Peruvian context of military and civilian dictatorships highlights some of the difficulties in interpreting the success of such a prescription. These 'good governance' ideals depend, in practice, on the fiscal capacity, human resources and legitimacy of the decentralised government or civil society entities to which responsibility is passed. These capacities have to be understood in relation not just to central government but also to the international private sector as we will see in the particular case of water and sanitation infrastructure.

2.3 Infrastructure and Services: moving from a governance framework to a socio-technical systems perspective to conceptualise the provision of urban water and sanitation provision

Who's zoomin' who?

Aretha Franklin album title, produced by Narada Michael Walden, 1985

> The urban poor are linked into structures of governance through their dependence on the delivery of infrastructure and services by city institutions, as well as through the impact of meso- and macrolevel policies.
>
> (Farrington et al. 2002):30

The second analytical category of the SL framework deals with collective assets beyond individual households. By treating these separately from household assets, the SL framework acknowledges that what happens to be lying around, buried in the ground or hovering in the social ether near households is not automatically accessible to householders. Instead, there is a distinction between assets, which depend on the quality of the connection at the level of the individual household, and infrastructure and services, which depend on the quality of the networks of markets, services, infrastructures, ecosystems or institutions to which households can potentially connect themselves.

At the macro level also, infrastructure plays an important and complex role in development: important because economic growth turns on efficient production and consumption and complex because the institutional

arrangements which support its provision are not simply economic but also of a strongly socio-political and technical character. As such, debates over the governance of infrastructure and its links to human development and the environment have paralleled the thinking on more general jostling between the activities of the state, the market and civil society.

2.3.1 Governance of provision: the international context

While President Alberto Fujimori was consolidating his position in Peru[13], the World Bank was publishing its 1994 World Development Report, "Infrastructure for Development", a road map for overcoming underinvestment in infrastructure (World Bank 1994). At this document's heart was the conviction that water was an economic good[14] and that the systems for delivering it should recover their costs and generate returns for the private sector players good enough to invest in them[15]. This report went along with the neo-liberal caricature of the public sector as pathologically unreliable, corrupt and, because of chronic underinvestment, unable to provide enough connections to meet consumer demand (Johnstone & Wood 2001).

Significantly, the 1994 World Development Report was still lumping electricity, telecommunications and water and sanitation together under the single heading 'infrastructure'. By contrast, the 2004 World Development Report, this time in a curly, pastel font and entitled "Making Services Work for Poor People", was bundling water and sanitation and electricity together with the health and education sectors (World Bank 2004). This softening in the title and graphic design reflected what had been real and serious challenges to the World Bank's 1994 prescription.

The sea change came at the end of the nineteen nineties after several disastrous attempts to privatize water infrastructure in developing countries,

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[13] See Chapter 4

[14] Lending institutions like the World Bank held that water should be regarded as a commodity, following the Dublin Principles, and cost-recovery and self-financing became the priorities for internationally funded water projects. The main tenets of this approach were: "to take environmental issues more seriously [integrated water resource management], to favour markets over government provisioning, and to favour decentralized over centralized governance." (UN-HABITAT 2003):158.

[15] The World Bank's 1994 infrastructure ownership models: A: public ownership, operation by enterprise or department; B: public ownership, operation contracted to private sector; C: private ownership and operation "often [all though not always!] with regulation"; D: community and user provision: "local, small-scale infrastructure" which "complements central or provincial services". Options B and C given the most attention (World Bank 1994)

perhaps most notoriously in Cochabamba, Bolivia[16]. These high profile failures, combined with stubbornly persistent gaps in provision, brought the World Bank to a recognition that, regardless of whether utilities were privately or publicly owned, a key policy objective ought to be 'organizational strengthening'. This also gave way to an admission, even among die hard neo-liberals, that there might be value in understanding different socio-cultural circumstances before rolling out a generalised set of operational models for water and sanitation infrastructure (Nickson 1997):184.

Just ahead of the publication of the 2004 World Development Report, Jessica Budds and Gordon McGranaham gave a damning assessment of the state of the sector in a paper entitled "Are the debates on water privatization missing the point?". Using case studies and empirical evidence from Africa, Asia and Latin America, these authors made the following comments:

> In practice, shifting international opinions regarding the appropriate roles of the public and private sectors in water and sanitation provision respond to broad political trends far more closely than they respond to evidence emerging from experiences in the water and sanitation sector... It would be a serious mistake to assume that private sector participation will attract sufficient finance to play a major role in providing adequate water and sanitation to deprived neighbourhoods.
>
> (Budds & McGranahan 2003):111

Budds and McGranaham also forcefully pointed out that classifying providers as either public or private (and all that those terms have come to mean) neglects civil society organizations and any other model of provision that might fall between the floorboards of definition.

The limits of the public versus private dichotomy are further exemplified by the work of Hardoy et. al. in Moreno, Buenos Aires, when they argue that better governance[17]must appreciate the organizational, physical, technical and socio-economic challenges of urban infrastructure management. The authors poignantly conclude that "none of these barriers [to infrastructure management] can be overcome by the sole actions of any one of the actors involved" (Hardoy et al. 2005):199.

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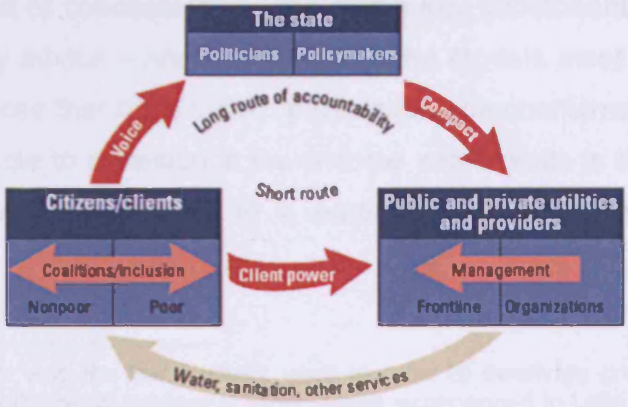
[16] Complex failure of concession contract attributed to macro-economic context in Bolivia, anti-imperialist rhetoric and exclusivity of contract which sidelined those with autonomous systems: the better off and small independent private providers (Nickson & Vargas 2002).

[17] David Satterthwaite scales urban governance by *proximate* factors (neighbourhood levels of capacity and tenure security), *contributory* factors (weak local utilities/government at city or municipal level) and *underlying* factors as the regional, national and international levels (UN-HABITAT 2003).

By 2004, then, with even World Bank economists confessing that "the increased role of the private sector in infrastructure is producing secondary distributional effects that have been too often underestimated or ignored by policy-makers" (Estache et al. 2001):1180, the debate had to become more intelligent, critical and nuanced. This meant a shift from the World Bank emphasis on privatisation towards the framework shown in Figure 7, a form that is by now suspiciously familiar to the reader. Essentially this is the good governance framework applied to service delivery but with the important modification that the 'market' space for providers includes public, private and the not-for-profit sector like communities and NGOs.

In this model, tying citizens to the state is "voice"[18], a mechanism by which the state communicates with service providers through jointly negotiated compacts[19]. Circumventing this 'long route to accountability' is the notion of client power or the ability of clients to communicate directly with providers via their day to day transactions. Terms like partnership[20] and participation pepper the World Bank report and participation is used interchangeably to refer both to private investment and political participation[21].

Figure 6 World Bank Framework for Governance of Services



[18] "voting and electoral politics, lobbying and propaganda, patronage and clientelism, media activities, access to information, and so on." (World Bank 1994):47

[19] "broad, long-term relationship of accountability connecting policymakers to organizational providers. This is usually not as specific or legally enforceable as a contract. But an explicit, verifiable contract can be one form of a compact." (World Bank 2004):47

[20] Budds and McGranaham point out that this term "tends to be used to refer to contractual arrangements in which private companies assume greater responsibility and/or risk, it can also imply that actors share objectives, outside a contract when they do not" (Budds & McGranahan 2003):89. Fowler suggests that it can disguise inequitable power relationships between entities, especially northern and southern NGOs and that it has forgotten its original meaning which was "humanitarian, moral, political, ideological or spiritual solidarity between NGDOs in the North and South that joined together to pursue a common cause of social change." (Fowler 2000):25

[21] Finance is direct from clients (cost recovery); altruistic NGOs (or their altruistic donors); citizens via taxation; from other governments with their own complex interests; and from the private sector seeking to generate a return.

The World Bank triangle is neat and tidy, allowing different arrangements to be labelled and analysed, but it is also simplistic. In Chapter 4, for example, we will see Peruvian provision arrangements which persistently fall outside the national policy framework and blur many of these accountability relationships.

In fact, there is a wealth of research on the provision of water and sanitation in the patches of cities that fall outside the reach of "formal" systems; variously described as informal, peripheral and marginal[22] (geographically, economically or both). A general picture of what is meant by this is given by UN-Habitat:

> In most low- and middle-income nations, unplanned and uncontrolled city expansion produces a patchwork of different developments... [Consequences] include segregation of low-income groups in the worst located and often the most dangerous areas, to which it is difficult and expensive to provide water, sanitation and drainage. The haphazard expansion of settlements generally builds into the urban fabric greatly increased costs for providing infrastructure as new developments that need connection to networks of water mains and sewerage and drainage systems spring up far from existing networks
>
> (UN-HABITAT 2003):145

The work of Ana Hardoy and Ricardo Schusterman on the privatization of water infrastructure in the informal settlements of Buenos Aires, presents four models[23] for operating in low-income areas shown in Figure 8. They are working in a context of concessions – one of the key components of the World Bank's 1994 policy advice – and conclude that the models most likely to succeed over time are those that have built-in participation mechanisms after observing that a chief obstacle to provision in low-income settlements is the "lack of capacity of private operators to work in a participatory way" (Hardoy & Schusterman 2000):75.

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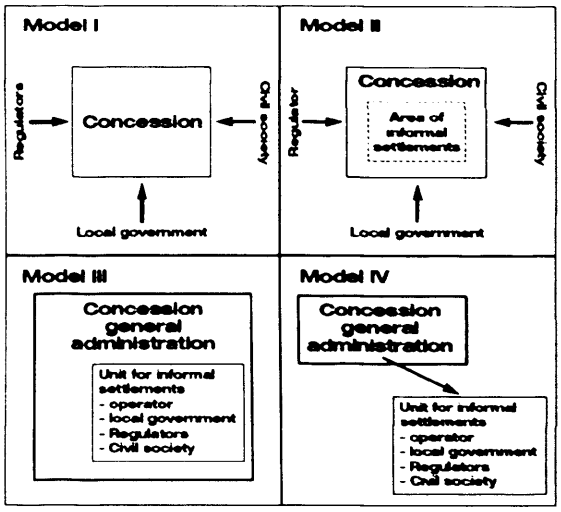
[22] "*Marginality* was the term initially used to refer to dwellings on the periphery of the city generated by the rapid process of urbanization experienced in Latin America during the 1950s and 1960s." Later it became synonymous with "those who were marginal to the process of capital-intensive industrialization associated with ISI" with different schools coming to different conclusions as to whether these margins were in transition towards full integration or were an inevitable consequence of capitalism, giving rise to notions of the formal versus the informal economy (Clarke 2002):93. Clarke concludes that "As the state has retreated, the changing nature of urban economies has increased the reliance of the labour force on precarious employment...The vast urban populations in Latin America are currently more marginal from the formal economy than at any time for half a century." (Clarke 2002):95.

[23] In Model I private concessionaires have no special arrangements for informal settlements. In Model II, (the one adopted in Buenos Aires) the concessionaire can treat informal settlements separately. In practice, this has meant limited coverage because negotiations have to take place on a neighbourhood by neighbourhood basis rather than through a formally agreed framework. Models III and IV both have participatory mechanisms built in (the first within the concessionaire and the second in a separate provider). Model IV proved controversial with the respondents because it risked leading to the designation (or perpetuation) of informal neighbourhoods as "second-class".

Figure 7 Four model governance square (Hardoy & Schusterman 2000)



These authors see the key ingredients for successful provision in low income areas as political will, funds dedicated to low-income settlements and a community – "even if it has difficulty organising" – that is supported by NGOs or universities (Hardoy & Schusterman 2000):75. In addition, they cite a need for more open attitudes to "differentiated" levels of service (and price) which, Hardoy et. al. argue, a private operator can justify more easily.

Moving North to Bolivia, Rocío Bustamente reports not on the immediate possibilities for privatization, but on the need to support community-managed systems[24]:

> There is a clear gap in policy, and lack of support, to these community-managed systems. This is illustrated by the widespread assumption that improving sustainability is partly analogous with getting people to pay more for water and sanitation services, undervaluing the huge non-monetary contributions that many communities make in developing, operating and maintaining these systems.
>
> (Bustamente et al. 2004):2

Researchers at the Development Planning Unit, University College London also identify the need for providers to engage with communities and their systems, with reference to a detailed Venezuelan case study. In this example, the lack of capacity for participation in Caracas' unwieldy water entity,

Hidrocapital, has been successfully institutionalized by developing community relationships through innovative Water Forums:

> This cultural change undertaken by HIDROCAPITAL ... was a key step toward resolution of conflicts over water, especially in the lower-income communities. Frequent breakdowns of service were settled by activating growing protest mechanisms that ranged from blocking roads and highways to violent occupation of water company facilities. A reactive management model which sought only to keep problems under control was replaced by a mechanism – now a formal one – of public action: the Water Forums (Mesas Técnicas de Agua). Through that mechanism, HIDROCAPITAL and the communities articulate responses to solve service problems and anticipate new demands and solutions. The success of this experience, without precedent in the country, has turned these water tables into forums for negotiation and resolution of disputes, not only on provision of water service (construction, maintenance of facilities, management of the service) but also regarding other problems involving community life.
>
> (Development Planning Unit 2008):47

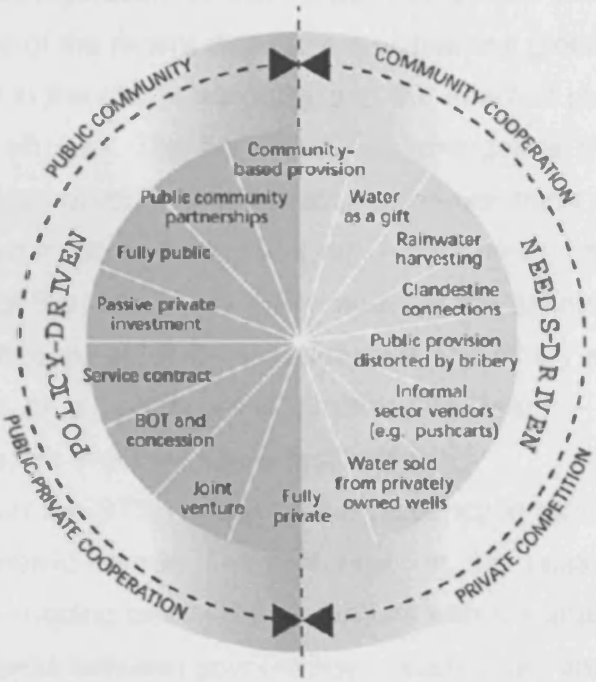
Giving a regional perspective, the 2003 publication Independent Water Providers in Latin America, demonstrated that small, entrepreneurial water providers coexisted alongside overstretched utility companies, offering more mobile alternatives such as tanked and bottled water (Solo 2003):12[25].

These examples and other detailed case studies and workshops have contributed to an expanded analytical framework for understanding water and sanitation provision in the peri-urban context. The 'circle' put forward by Adriana Allen is shown in

[25] This ties in with another variation on Hardoy et. al.'s Model IV is micro-privatization: "Local authorities, or national governments, with or without subsidy from national or international sources, can employ micro-enterprises to deliver urban public services which are presently costly, ineffective and inequitably distributed" (Rutherford et al. 2002):123.

Figure 8 (Allen et al. 2006):339. It can accommodate the 1994 World Bank prescription in a limited, bottom left slice. The 2004 World Bank 'triangle' spans the policy-driven semi-circle, while Hardoy and Schusterman's models straddle both halves. Bustamente et al.'s community management sits in the upper most segment.

Figure 8 The DPU Circle: from an unpublished 2006 paper by Adriana Allen



The divergence of policy and practice in water provision is by no means unique to these examples and in Chapter 4, I will argue for similar patterns in Peru. Neither is this divergence completely framed by a governance perspective that depends on the explanatory power of civil society, government and market activity since, on the ground, patchy policy implementation is reflected in the spatial incoherence of cities; heterogeneity in terms of livelihoods, infrastructure and investment, which is in turn shaped by social life and by pieces of infrastructure that, once established, may resist the influence of governments, markets and civil societies.

To take this analysis to the next stage, I turn now to the concept of socio-technical systems as one way of understanding the complex interaction between governance and livelihoods.

2.4 Socio-technical systems: dissonance and resonance with urban governance

> ...globalization expresses the widening scope, deepening impact and speeding up of inter-regional flows and networks of interaction within all realms of social activity from the cultural to the criminal.
>
> (McGrew 2000):345

This section argues for socio-technical systems as a lens through which to examine the configuration of the infrastructure that binds cities. I begin by reviewing some of the recent discourse on cities and globalisation; both the role that cities play in the global economy and the effect of global economic trends on the shape of cities. The argument that emerges is that sophisticated and connected global networks of information bring with them economic polarisation and segregation in cities. Taking this argument further, I turn to recent work on Socio-Technical Systems which conceptualises the 'splintering' heterogeneity of cities not just in terms of information networks and binary economic poles but as the interaction of all entrenched, physical hardware – pipes, wires, roads, rivers – and people and their social institutions.

Building on the STS critique of the tendency to attribute urban processes to global economic trends, I reflect next on the relative influence of local governance in shaping cities. This resonates with the analytical link that the SL framework expects between governance, infrastructure and households.

Finally, to give STS a more tangible form in relation to the infrastructure and services element of the SL framework, I look at attempts to categorise and describe socio-technical infrastructure systems in terms their modes of production and household consumption.

2.4.1 Privilege and bypass

Urban governance is an arena in which local and global influences routinely spar. One influential body of thought argues that globalisation is the dominant influence shaping the internal structure of cities. Jodi Borja and Manuel Castells in their work on "The Management of Cities in the Information Age", start from the premise that mega cities are established around a connection to a global network. Borja and Castells describe cities by turns as the protagonists, the economic and political agents and the "complex and multidimensional social agents" (Borja & Castells 1997):90 which form the nodes in global economic and infrastructural networks. In the same way, Montgomery et al. think that a city is defined by its position in these networks:

> ...the multiple strands of economic and social interchange that are knit together in cities. These strands also reach to rural areas, and they have links that extend to the international arena. But they intertwine in cities, and from the many knots and nodes there emanates a quality that might be described as urbaness.
>
> (Montgomery et al. 2004):67

Montgomery et. al. laud the inter-connection of all these strands as if they offer some sort of coherence but, while strong global connections may give a sense of internal integration, global cities tend towards both social and spatial segregation (UN-HABITAT 2003):145.

Borja and Castells, for example, view the global economy – markets exchanging capital and skilled labour – as striving to include valued people and places all over the world while excluding what is devalued or undervalued. They paint an economy so uncertain that it "limits strong economic initiatives which lend cohesion to the social fabric" (Borja & Castells 1997):92. So although there may be a network of urban nodes where skills, power and capital are concentrated, between these nodes and potentially within the same city, is an economy characterised by productivity and dynamism on one hand and social exclusion on the other. With examples from Asia and Latin America, the pair shows that cities are hubs of information with the most successful urban hubs able to adapt their structures and form networks which merge the city's economic and urban fabrics. According to these authors, persistent and increasing inequality, poverty, exclusion and a crisis in the provision of housing and urban services are driven by a new "logic" borne out of capital accumulation, segmented production and high-speed communication.

Castells and Borja conclude that social cohesion, as opposed to fragmented ghettos of rich and poor, can only be achieved by reversing past attempts to create socially homogenous districts:

> ...large projects of ambitious, socially heterogeneous housing programmes is the best guarantee of urban integration...basic education and basic health services should be accessible and free to the entire population. There is no citizenship without access to the education and culture of the city, without continuous training, without accessible health services or without collective services such as water and the treating and ecological conditioning of waste.
>
> (Borja & Castells 1997):253

Saskia Sassen also sees this segregation as part of an economic polarization which she observes within typical 'global cities'[26]. She sees an almost binary split in income and occupations with high-end, financial sector earners creating demand for low-wage services through the residential and commercial gentrification that they stimulate. On Sassen's view, the "expansion of low-wage jobs" is "a function of growth" (Sassen 2001):10.

This connection between local exclusion and global connection is also picked up by Stephen Graham:

> With many contemporary infrastructural investments focusing on linking certain urban spaces across international boundaries, such 'infinite' local disconnections often rest cheek-by-jowl with glamorous infrastructures connecting the 'local' with the 'global' scales.
>
> (Graham 2000):116

In a wide-ranging examination of urban heterogeneity, Simon Marvin and Stephen Graham make a case for the 'splintering' of cities: a process of 'bypass' whereby the strengthening of connections between the most valued people and places, (i.e. those judged to be lucrative and profitable to the infrastructure service providers), leads to a weakening of the connections between the least valued users and places (Marvin & Graham 2001):288. The authors build on actor-network theory and the theory of Large Technical Systems (LTS) which proposes that the formation of technological, infrastructural networks takes place when interrelated clusters of innovation cohere. In addition, the authors do not ignore political economy as a shaping force and consider the flows of people, capital and goods as well as the aspects of these which are fixed and embedded in the fabric of cities. Lastly, relational theories occupy a prominent place in the analysis – the importance of dynamic social relations and the idea that social coherence is accidental and unstable. These all conspire to create enclaves of investment while raising the logistical costs of everyday life for swathes of marginalised city dwellers whose proximity to infrastructure does not equate to access.

In recognition of the fact that enclaves of wealth and swathes of poverty are so interspersed that they should be examined within the same theoretical framework, the authors deliberately mix examples from 'north' and 'south'. Arguing that the configuration of networked infrastructure is highly biased and

[26] London, New York and Tokyo

reinforces existing biases leaving "network ghettoes", described as "unmoved" (without public transport), "unwired", "unwatered" and "unwarmed" (Marvin & Graham 2001)289:297. This splintering of cities is paralleled by the 'unbundling' of infrastructure which fragments or segments networks to serve a market sector or a preferred territory.

Splintering is part of a theoretical approach which sees "modern urbanism as a socio-technical process" with infrastructure networks bringing "heterogeneous places, people, buildings and urban elements into dynamic articulation and exchange" in a way that is "necessarily both social and technical" (Graham 2000):115. Similarly, in a paper entitled "Fetishising the Modern City", Kaika & Swyngedouw, also see the city "as a process of flows" and "technological networks" (Kaika & Swyngedouw 2000):120. For them, the city is "a 'hybrid' of the natural and cultural, the environmental and the social" (Kaika & Swyngedouw 2000):121. The hybrid idea is invoked to describe the mixture of modern and traditional artefacts that continue to coexist in spite of efforts to modernise[27]. Kaika & Swyngedouw remark that:

> Despite efforts to manage and control the city, it remains a realm carved out of the dialectics between clean and dirty, justice and injustice, underworld and high society, basements and lofts, Hell and Heaven.
>
> (Kaika & Swyngedouw 2000):136

Similarly, with examples of unorthodox organisational arrangements for running local services in Karachi, Pakistan, Joshi and Moore observe that they are so "'mixed, or ' 'hybrid', that they seem almost to defy categorisation." (Joshi & Moore 2004):34. The authors use the term institutionalised co-production to describe these phenomena to argue that:

> We cannot sensibly treat such 'ambiguous' organisational arrangements as hangovers from some non-democratic or economically backward past, that will shrink further when fully exposed to the forces of modern, democratic rationality, and be replaced by an ever more Weberian state where the lines between public and private are drawn ever more clearly and sharply.
>
> (Joshi & Moore 2004):44

Bruno Latour, in his essay *We have never been modern* (Latour 1993), tackles this theme by advancing an idea of actors in networks as combinations

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[27] "Due to its primary origins in engineering and architecture, 'order', 'integration', 'balance', 'unity' were always among the primary goals of master plans directed at the construction of a well-defined and controllable spatial organisation." (Balbo 1993):24.

of people and things. For Latour, the aspects of our development that look stable and ubiquitous only seem that way because they are set in robust networks of ideas, individuals, collectives of people and "technological artefacts" that persist for a while. Latour insists that when we bandy about the word 'modern', we are making all sorts of outdated assumptions about progress and science. We think unquestioningly, for example, that there is something homogenous and universally accessible about our 'modern' infrastructure[28] but Latour tells us:

> Between the lines of the network there is, strictly speaking, nothing at all: no train, no telephone, no intake pipe, no television set. Technological networks, as the name indicates, are nets thrown over spaces, and they retain only a few scattered elements of those spaces. Thev are connected lines, not surfaces. They are by no means comprehensive, global or systematic, even though they embrace surfaces without covering them and extend a very long way.
>
> (Latour 1993):118

The splintering processes of privilege and bypass are driven in part by the global economic forces described by Borja, Castells and Sassen. They are also shaped by an interaction between people and technology, framed by Latour as a network of actors and by Swyngedouw and Kaika as hybrids. What is interesting to this urban research is that the myth of homogenous, universal infrastructure seems to persist in spite of divisive globalisation and disobliging local messiness.

2.4.2 Local resistance

Saskia Sassen's rather deterministic views of globalisation are criticised by Richard Batley who argues for the influence of local governance above globalization in shaping cities.

While elsewhere Batley is very concerned with fragmentation and recognises that it is "at the city level, where proximity of the dynamic and marginalised sectors of the economy is most obvious..." (Batley 1997):339, he argues that on Sassen's deterministic view of cities in a global economy, few cities end up with any social agency. In contrast, Batley's idea is that the destiny of cities "is not determined just at the global level, or by their inherited starting

[28] This modern, homogenous vision of cities is"[d]ue to its primary origins in engineering and architecture, 'order', 'integration', 'balance', 'unity' were always among the primary goals of master plans directed at the construction of a well-defined and controllable spatial organisation." (Balbo 1993):24

point: local agents can also be influential" (Batley 1997):341. He claims that different cities come up with different responses to common pressures and that this puts paid to any ideas of inevitability about the impact of globalisation on cities.

In part, the power of Batley's argument is that it comes from case studies in developing world cities. He claims, for example, that "the level of inequality within and between Latin American cities is greater than can be explained by globalisation" (Batley 1997):337. He goes on to argue that although the globalisation model of Sassen and Borja and Castells does predict an increase in inequality with income growth, in Latin America the gulf between rich and poor has been higher than in East Asia and Europe (where growth rates have been higher) and higher than Sub-Saharan Africa (where growth has been much slower). Bately thinks that this came about during the nineteen-nineties because the Latin American middle classes had been so battered by structural adjustment that there was no strong social grouping to lobby for urban policies that might allow for some redistribution of wealth. For Batley, then, Latin America's distinctive urban inequalities are "products of policy, not of globalisation" and he singles out residential segregation as something that has become an "administratively consolidated fact" in some Latin American countries because of tight municipal boundaries and the lack of cross-subsidy between municipalities (Batley 1997):338.

Batley's second culprit in the persistence of urban fragmentation, is the lack of state-led social expenditure, not just in terms of tax and spend but also in creating an enabling environment for private investment. Indeed, as Montgomery et al. argue with reference to the social dimensions of this spatial marginality:

> Spatial segregation can have the effect of enforcing homogeneity in local social network ties and resources, suppressing some of the diversity in social relations that can benefit the poor.
>
> (Montgomery et al. 2004):43

> Resources cannot simply be expected to materialize, as if by spontaneous generation, in the personal social networks and local associations of poor city residents. Links are needed to the powerful actors and institutions that generate resources and influence how they are distributed.
>
> (Montgomery et al. 2004):47

Bately also describes the quest for resources as a networking process, which he asserts is a commonplace approach to urban management in Latin America:

> Social agents, including local politicians, officials, economic groups, firms and households, have some capacity to build economic links, to 'navigate' opportunistically, to advocate and lobby for local interests, to mobilise local resources, to apply and redistribute resources so as to improve the local quality of life...
>
> (Batley 1997):344

Batley admits, however, that the urban economic 'winners' will only be persuaded to petition governments to change such policies when they are facing critical political instability, environmental degradation or when the city becomes unattractive to investors: "a recognition by the socially 'included' that exclusive cities do not provide stable conditions for local or global investors" (Batley 1997):345.

There is, then, an alternative to deterministic and divisive globalisation in shaping cities but the prospects for local agency are uncertain and depend on whether coalitions of winners and losers are able to foment change in response to urban crises and whether such coalitions endure. These conditions are embodied in the coexistence of attempts at universal provision, splintering, community management and disobliging local messiness: the socio-technical configuration of water and sanitation infrastructure.

2.4.3 Networking between socio-technical scales

As well as local political resistance to splintering, Marvin and Graham insist that 'perfect' splintering is ultimately scuppered by the technical impossibility of insulating privileged enclaves from urban or regional services such as power and water. They conclude with a plea for the development of more modest, local networks and argue that these should be accompanied by the exposure and regulation of inequalities in infrastructure connections, perhaps lest the modest and local encourage insulation.

The first of these, the technical barriers to insulation, when combined with Batley's local agents begin to tell a complex story of tension between abandoning the ideal of universal provision and finding ways to fill the gaps. This is examined by Bas van Vliet, Heather Chappells and Elizabeth Shove in their work on Infrastructures of Consumption. These authors suggest that:

> Although the general trend is assumed to be one of a shift [away] from a 'universal' mode of provision, the reality is a more complex situation in which private and public priorities coexist and in which networks are both converging globally and fragmenting locally.
>
> (van Vliet et al. 2005):38

The second proposal for resisting splintering is the adoption of more modest or small-scale technologies. This comes up elsewhere in Marvin's work when the notion of socio-technical systems is applied to formal and informal water systems in Bolivia. Here, Marvin and Laurie find 'two circuits' of provision and conclude that these are:

> ...intimately related to each other in that the continued existence of the formal sector requires large numbers of potential users to join the informal sector. Although networks of formalised and informal supply are powerfully disconnected from each in technical terms, their continued existence is supported by social relations that institutionalise the unequal access to water resources....meshing the incorporation of informal circuits with the formal water network will require the development of new types of knowledge no longer monopolised by engineers; innovative and more complex social relations with users; and a social context for the use of smaller-scale water management technologies.
>
> (Marvin & Laurie 1999):344

Small-scale networks, however, are not the only possibility for van Vliet et al. In fact, these authors compare sustainability of infrastructure by its degree of social and technical connection to other infrastructures rather than allowing themselves to be sidetracked by the debate over 'small-scale' versus 'large-scale' configurations. They make an important point in this connection:

> The technological scale of a system is too easily assumed to be managed by a social organisation of a similar scale.
>
> (van Vliet et al. 2005):64

These authors go on to devise a framework to describe the coexisting, and not necessarily sequential, phases of infrastructure development based on patterns observed in the UK and The Netherlands. These configurations of infrastructure shape not only the technical systems but also users' experiences of infrastructure services. More interestingly, they give an idea of the configurations that fall between privilege and bypass:

Table 1 van Vliet's modes of organisation

Autonomous	Co-providers, localized resources, local stand-alone, self-managed and responsive grids
Piecemeal	Customers and suppliers, patchwork of grids, unregulated, non-standard, designed for peak loads with idle spare capacity
Integrated	Consumers and promoters of diversified demand, semi-integrated local and regional grids, designed for diverse loads to exploit spare capacity and smooth demand profiles
Universal	Passive beneficiaries and public providers, uniform services, highly integrated national and regional super grids, demand not differentiated just met by extending networks
Marketed	Purchasers and promoters of differentiated products and services, partially fragmented grids matched to diverse, monitored and manipulated needs

Reproduced from Table 3.1 (van Vliet et al. 2005):33

To look at what is happening at the two extremes of van Vliet et al.'s modes of organisation, two final perspectives are introduced . When Marvin and Graham's call for the exposure and regulation of inequalities or Batley's coalitions of winners and losers are not spontaneously erupting in response to urban crises, users in autonomous modes of organisation have responded to stretch their configurations of infrastructure. One example of this is described in Arjun Appadurai's brilliant account of an alliance of slum dwellers in Mumbai. Through what are essentially participatory events such as "housing exhibitions" and "toilet festivals" (Appadurai 2002):34, he describes how slum dwellers demonstrate to each other techniques and possibilities for improving housing and sanitary systems. The author coins the term "horizontal, global networking" (Appadurai 2002):25 to describe encounters with slum dwellers in other countries which allow "exposure, exploration" (Appadurai 2002):39 and exchange through face-to-face meetings. This ability to tap into grass-roots knowledge and experience from elsewhere stretches the socio-technical scale of infrastructure and sees it transition between configurations. Appadurai describes the arrangement as one based on partnership, "politics without parties"(Appadurai 2002):29 and a "complex political vision" which seems to emerge from "a logic of patience, of cumulative victories and long-term asset building" (Appadurai 2002):30. Echoing this, Celine d'Cruz of Slum Dwellers International, India when challenged about the scaling-up of grass-roots organisations, explained that sustained management was about building a bridge between political leadership and bureaucratic administration; what she termed "institutionalising charismatic leadership" (N-AERUS Conference, 6th-8th September 2007, University College London).

At the opposite extreme, this last example presents sustainable infrastructure configured as a 'marketed' mode of organisation. Arjan van Timmeren, Jón Kristinsson and Wiek Röling develop a proposal for sustainable configurations of infrastructure using a comparison between two classes of complex system: homogenous and non-homogenous networks (Albert et al. 2000):379[29]. In homogeneous networks every node has the same number of connections but in non-homogenous networks some nodes have many more connections than average. The nodes in these non-homogeneous systems form 'hubs' of connectivity, similar to Borja and Castells city nodes.

Van Timmeren and his team then provocatively rename homogeneous and non-homogeneous networks as 'egalitarian' and 'aristocratic' and conclude that an 'egalitarian' network is less resilient to the random failures that happen as infrastructures age or are not properly maintained. The high degree of interconnectedness in an 'aristocratic' system is said to reduce the typical time, distance and associated losses needed to transport information, energy and materials around the network and is, hence, a more sustainable configuration.

Using these assumptions, they conclude that sustainable development demands decentralised but connected, autonomous clusters, rather than a tendency to absorb sub-systems into highly centralised infrastructure. Their process of transforming our existing, unsustainable infrastructure starts with the strengthening of weak nodes and the introduction of additional connections between interconnected, international infrastructures. Large-scale, centralised networks may persist but alongside local organisation with reduced central administration, "more exact attribution of use of network costs to certain customers" (van Timmeren et al. 2004):5, smaller investments, lower risks, more efficient treatment of flows and the ability to unbundle and tailor the system to the user. Although they accept that such networks are complex to organise, maintain and inspect, they claims that:

> Differentiation and urban flexibility are pre-conditions for anticipating long-term uncertainties, due to actual liberalisation processes, rising complexities and even sabotage
>
> (van Timmeren et al. 2004):6

[29] The characteristics of these two complex systems are related to their 'connectivity': a probability function giving the likelihood that each node in the network will have a certain number of connections to other nodes. Homogeneous networks have a probability function that decays exponentially while non-homogeneous networks have a probability function that decays as a power law.

This more abstract view, in an attempt to model infrastructure configurations which stretch, transition and interconnect, highlights the tendency for the best connections to reinforce themselves. It goes further, however, by suggesting that the homogenous, universal model is ultimately more fragile and vulnerable to neglect and that it is networking between the 'hubs' that offer stability. In the following section, I will examine the vulnerability of collective infrastructures in the context of governance, physical infrastructure and household livelihoods.

To conclude, the World Bank "triangle", Hardoy's "square", the DPU's "circle", van Vliet's "coexisting modes" and "co-provision" as well as the more amorphous 'hybrids' and "co-production" give some idea of the governance challenges of sustainable water provision in the 'splinters' of cities summarised by Marvin and Graham:

> The 'messy' practices of embedding, building and maintaining infrastructure networks beneath, through and above the fabric of cities thus infuses the politics of metropolitan areas, requiring complex regulatory articulations between markets and national and local states
>
> (Marvin & Graham 2001):12

Socio-technical systems offer a bridge between global and local governance and layers of interconnecting infrastructure that meld them together. Socio-technical systems are configured by global processes, local coalitions and sometimes by modes of organisation which find unconventional routes or subvert idealistic governance structures. The point is that the configuration of systems that might reach out to the edges of Latin American cities is bound up in complex arrangements of differentiated provision *and* differentiated consumption: tampering with one, shapes the other and vice versa. Socio-technical systems are therefore mediating between governance and households. In the final section of this review, I propose a framework to bring together the notions of risk and vulnerability at the heart of the SL analysis and the role of infrastructure in mediating between households and governance.

2.5 Assets and Vulnerability: enhancing the sustainable livelihoods framework using socio-technical systems

> Individuals and groups differ markedly in their power to influence these processes [of market regulation]; indeed, they differ even in their capacity to aspire to such influence.
>
> (World Bank 2006a):28

At the centre of the livelihoods framework is a pentagon of assets that householders must manage in order to mitigate both run of the mill and out of the ordinary change. The extent to which individual households are able to mitigate the risks associated with these changes is understood in terms of a vulnerability context, their access to infrastructure and the prevailing governance arrangements for the city and its systems.

In this final section, I argue, firstly, that the notion of vulnerability - the different degree to which households are able to buffer risk - resonates with the heterogeneous distribution of infrastructure and patterns of consumption that are conceptualised by the STS approach. Secondly, I claim that an understanding of the complex relationship between household assets and collective assets beyond the household can be enhanced through an STS lens.

2.5.1 Vulnerability: resonance between sustainable livelihoods and socio-technical systems

Caroline Moser, whose groundbreaking work on urban livelihoods in Latin America has had an enormous influence on World Bank policy in relation to poverty, describes vulnerability as:

> ...insecurity and sensitivity in the well-being of individuals, households and communities in the face of a changing environment, and implicit in this, their responsiveness and resilience to risks that they face during such negative changes. Environmental changes that threaten welfare can be ecological, economic, social and political, and they can take the form of sudden shocks, long-term trends, or seasonal cycles.
>
> (Moser 1998):3

Moser was writing in 1998 to a backdrop of urban crises and a wealth of debate on the limitations of conventional poverty reduction strategies. She thus argues for a better appreciation of the poor as managers of complex asset portfolios, seen as the strategic juggling of household assets to buffer risk and reduce vulnerability.

In this way, the SL framework understands vulnerability as more than just an incomplete indicator of poverty, like income. Vulnerability acknowledges a spectrum of deprivation that is both temporal and chronic (Ray 1998):252, linked to the environment (Hardoy et al. 2001):346 and which affects access to

resources and influence and even the ability to aspire to influence (Wratten 1995):14.

On this last point, even the World Bank now regards these differences or inequalities in access as not just of intrinsic interest but as factors that in themselves act "to curtail economic dynamism" (World Bank 2006a):28. In its 2006 World Development Report on Equity and Development, the Bank concedes that inequalities tend to "combine, interact, and are reproduced through interlinked economic, political, and sociocultural processes." (World Bank 2006a):28.

This idea resonates with the dynamics of globalisation and urban splintering described in Section 1.4, particularly the processes of privilege and bypass through which inequalities are embedded in the biased configuration of socio-technical systems.

In addition, the interdependence implied by a socio-technical systems approach to privilege and bypass finds an important echo in Robert Chambers' call for sustainable livelihoods that enhance rather than damage the livelihoods of others. Next, I look at the socio-technical content of livelihood assets themselves.

2.5.2 Livelihood assets

At the centre of the framework are household assets. Acknowledging if not accepting academic criticism[30] of the asset concept, Robert Chambers reminds us that the things householders value as assets are neither universal nor immutable:

> ...the asset, seen by some academic critics as a liability, of a portmanteau character of commodious imprecision...has the advantage of inviting many interpreters to give their own meanings, and provides space for many definitions and dimensions.
>
> (Chambers 2005):201

With this encouragement, and in light of my fieldwork and other livelihoods research (DFID 1999), in this section I review each household asset category, arguing that physical, natural and social capitals are particularly relevant to the socio-technical configuration of infrastructure. In this way, I argue

[30] Academics are part of the concentrations of elite power that he so disparages so using the term 'academic critics' is to dismiss their technocratic hunger for precise definitions.

that a socio-technical systems approach helps to understand the relationships between household assets and collective assets.

Financial Capital might include salaries, wages, security of income, rental income, the surplus from selling food, crafts or livestock produced in the home, savings, debts and, particularly in urban areas, utility and food bills. **Human Capital** includes levels of education and training and the market value of these assets in a given context.

Physical Capital includes housing and security of tenure[31], additional rooms to let or space to undertake home-based production as well as elements of water, waste water, solid waste disposal and energy infrastructures which can sit far outside the households themselves. The quality of the household level connection to water infrastructure is an important component of its value as an asset and can be quantified using various indicators from the number of taps and presence of patio drainage to domestic arrangements for maintenance. Access to water as an asset, however, also depends on the supply network. Water is seen through the livelihoods lens not as a commodity but as a productive asset which, along with other infrastructures, arguably straddles the categories of Physical and Natural Capital.

Households tap into **Natural Capital** to support their livelihoods through a range of activities from growing crops to using fuel to cook food[32], and from rearing animals to disposing of household waste. Like Physical Capital, the Natural Capital[33] on which households depend is not necessarily local. Broadly, for example, Natural Capital can be understood as "[t]he services derived from air, water, soil, biological diversity, and recreation" (Woodhouse 2000):158. Hardoy et al. in Environmental Problems in an Urbanizing World include in these 'services' "the waste-assimilation capacities of ecosystems and of the whole planet" (Hardoy et al. 2001):348.

Hardoy et al. go on to make the point that the environmental impact of low-income urban dwellers tends to be small in terms of natural resource use

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[31] Farrington et. al. note the link between exclusion from city institutions and "irregular, illegal or informal" (Farrington et al. 2002):32. Alan Gilbert – on the basis of Latin American research – notes that, often, "housing is illegal only in the sense that it offends the planning regulations." (Gilbert 2002):259.

[32] In this study, the more "processed" the energy source, the greater the natural capital – access to electricity supplies means access to distant fossil fuels, arguably more valuable than locally gathered firewood. See Chapter 3.

[33] The other controversy with natural capital is whether or not it is "substitutable" for other capitals i.e. can worn out environmental assets be replaced with cash (Hardoy et al. 2001)?

and generation of waste (Hardoy et al. 2001):346. Similarly, Peter Newman writing on cities and the environment make the point that:

> [The urban poor] may live in settlements that offend the sensibilities of wealthy people and sometimes they have serious environmental health problems. But this is not the same as having an environmental impact – either global or local.
> (Newman 2006)::280

This leads back to Robert Chambers' argument that a preoccupation with the sustainable livelihoods of the poor avoids scrutiny of the unsustainable livelihoods of the powerful. McGranahan et al. reinforce this when they note that:

> The most serious problem with broad definitions of sustainability[34] is that they tend to marginalize the primary environmental concerns of the poor...The environmental priorities of the affluent clearly relate to sustainability: it is not so much the present as the future of the world's affluent minority that is at risk...
> (McGranahan et al. 1999):108

McGranahan et al.'s idea that the concerns of the poor and the priorities of the affluent may be at odds is a powerful argument for examining the livelihoods of both the urban poor and non-poor before dealing with what may or may not be sustainable[35].

The infrastructures and environmental concerns that link powerful and marginalised city-dwellers are thus a crucial entry point for understanding vulnerability and participatory, sustainable development. Access to these assets varies with household factors such as land ownership, income and rights to water resources. More importantly, beyond the household, the fertility of land and capacity for local ecosystems, river basins or the atmosphere to assimilate

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[34] "To say that sanitation systems in [low-income] cities are unsustainable...could mean that the infrastructure or facilities cannot be maintained...could mean that nutrient cycles are being disrupted...could mean that the cities are under threat from devastating epidemics..." (McGranahan et al. 1999):108

[35] This tension between the environmental priorities of the rich and the priorities of the poor played out at a global level at the 1992 Rio Summit, an event widely acknowledged to have catalysed an agenda for sustainable development (UNCED 1993). The summit came at the end of a decade dominated by neo-liberal policies promoting liberalized, international trade, cuts in public spending and the promotion of commodity exports. This led, in many cases, to more intense environmental degradation and severely reduced possibilities for national environmental regulation (Woodhouse 2000):161. This context, according to Mark Pelling, played out as a struggle between Northern industrialised nations pushing for technological solutions to environmental problems, and developing countries calling for solutions targeting the "international economy, debt, structural adjustment programmes and the role of transnational corporations" (Pelling 2002):285. These were global negotiations which highlighted rather than resolved tension between "national sovereignty and international obligations" or "government accountability to the electorate" and "interest politics" (Pelling 2002):288.

waste will all have an impact on households. Importantly, these impacts may well be determined by collective arrangements to which households have differential access.

Social Capital, despite its catchy title, is a semantic minefield of a term, simultaneously politically loaded and obfuscating in its imprecision. The crucial power of the social capital discourse, Caroline Moser reasons, is its appeal to economists as a "determinant of the feasibility and productivity of economic activity" (Moser 1998):4. For Robert Chambers, revisiting the changes in development language through the 1990s, this power is less benign[36]:

> It gave non-economist social scientists a credible means of persuading economists of the significance of social factors in development...it was a means of depoliticizing development, evading questions of inequalities of power and wealth....it justified working with civil society rather than local government....
> (Chambers 2005):200

Social capital has thus been invoked when economists are forced to explain practices like non-monetary exchange or behaviour that is not entirely self-interested. It is often identified with the 'traditional' rural sector where people living at close quarters provide mutual social support in contrast to a more anonymous urban sector. As I will demonstrate in the next sub-section, the development economist, Debraj Ray deals with the concept of social capital by jamming it into an orthodox economic framework with recourse to theories of rational risk mitigation that rely on information flow and low mobility in communities (Ray 1998):601.

In a more recent analysis, reviewing the early social capital debates in the introduction to *Democracies in Flux* (Putnam 2002):9, Robert Putnam juxtaposes various concepts of social capital: formal versus informal; thick, interwoven relations versus thin, fragile relations; inward-looking, self-serving versus outward-looking and concerned with public goods; and bridging between different groups versus bonding within homogeneous groups[37].

Meanwhile, as the arguments of Moser and Chambers predict, the World Bank's presentation of Social Capital conceives it as more than horizontal or

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[36] Hardoy et. al. warn that social capital should not be confused with "social sustainability" which has undertones of maintaining a particular social order (Hardoy et al. 2001):351. Carole Rakodi notes: "The role of social networks and the ways in which local political processes determine access by the poor to resources and assets are less well understood."(Rakodi 2002c):256.

[37] Putnam concludes that "we are still far from a canonical account" (Putnam 2002)9.

vertical ties but as a piece of governance critical to prosperity and sustainable development, that enables collective action by encompassing:

> ...institutions, relationships, and customs that shape the quality and quantity of a society's social interactions.
>
> (World Bank 2008)

From Debraj Ray's community-based definition to Moser's notions of cohesion and the World Bank's social interactions, it is clear that social capital has the potential to be spatially fluid. A household's social community is rarely so localised that it is limited only to geographic neighbours. For Montgomery et. al. in their essay *Why Location Matters*, "place is a spatial concept, whereas community is a social concept" and the community aspect of neighbourhood is important only when 'spatially proximate individuals' are involved in 'social learning' (Montgomery et al. 2004):31. Otherwise, city dwellers are linked to social networks which tend to override the spatial. These authors go on to articulate the relationship between networks and social capital:

> The term "network" is often employed when the focus is on mechanisms of information exchange and diffusion dynamics, or when specific linkages to resources are being highlighted. The phrase "social capital" is used when networks and local associations are being described as structures that might support collective action, enforce norms, generate expectations of reciprocity, or foster feelings of mutual trust. Because it places emphasis on the more durable features of networks and assigns prominent roles to associations and institutions, social capital is often invoked in discussions of civil society and governance.
>
> (Montgomery et al. 2004):41

The notion that more permanent or embedded social assets are somehow automatically positive is interesting in relation to the discourse of socio-technical systems. It overlooks the possibility that institutions – having ceded their capacity to network between people – might not be accessible to everyone. In other words, there is a fine line between wholesome community and excluded ghetto. An established neighbourhood support system might exist but could still fail to incorporate new arrivals or tenants: one person's social capital might be another person's exclusion (Mitlin 2001):157. McAslan makes a similar point:

> ...a community may participate regularly in informal social interactions, yet still be socially isolated from the valuable resources of the wider city or region.
>
> (McAslan 2002):141

As with the two preceding capitals, then, a household's stock of social capital is linked to, but not necessarily determined by, an active civil society and strong social and political institutions.

A socio-technical systems perspective, then, expects an analysis of household assets that goes beyond just the presence or absence of a connection and addresses the extent, quality and physical components of infrastructure as well as the links to infrastructure's governing institutions and the broader context of urban and national governance. In the next section, I propose a set of concepts that brings vulnerability, infrastructure and governance into a socio-technical systems framework.

2.5.3 Mitigating vulnerability: sharing risk through socio-technical systems

Robert Chambers sees one way of reducing vulnerability as the adoption of a diverse range of livelihoods, accompanied by complex adaptive responses:

> diversity spreads risks by adding species, enterprises, linkages and activities; complexity reduces risks through redundancy
>
> (Chambers 1997):172

Expanding for a moment on this idea, it is useful to look at a simple model of this diversity and complexity. Debraj Ray's text on development economics reproduces a classic model of social insurance which is helpful. He explains that two conditions must prevail for a social insurance arrangement to function: the incident must be verifiable; and it must not be subject to moral hazard[38].

Ray imagines a community that faces two sorts of independent risk; a localised, "idiosyncratic" risk that might affect a few people and an "aggregate" risk that affects everybody in the same way (Ray 1998):597. Even in a large group of people, no mutual insurance is possible against a random event that affects everybody. Insurance would be useless if two farmers with adjoining fields tried mutually to insure each other because, if one farmer suffered pest damage, the other is also likely to and the risks are not independent. The best insurance groups are subject to risks that are independent of each other.

[38] This is the probability of the incident occurring cannot be influenced by the actions of the insured individual.

To optimise mutual insurance, households and communities might choose strategies which mitigate exposure to the same set of aggregate shocks. For instance, if all members of a family participate in a similar activity and this principal economic activity is disrupted for some reason, every family member is hit in a similar way. A group with many sources of income, where each source of income is subject to independent risks is less sensitive to those risks and economists would:

> expect, then, that families will attempt to diversify their activities or spatial locations to lower the correlation between the incomes of family members
> (Ray 1998):605

Obviously, with a large enough – *diverse* and *complex* – group, all uncertainty is theoretically idiosyncratic and independent such that smoothing can be achieved but the larger the group, the worse the flow and reliability of information and the harder it is to verify incidents and avoid moral hazard: as Ray puts it, an "informational barrier kicks in and precludes insurance over very large anonymous groups or spatial distance" (Ray 1998):601.

By contrast, in a small, less mobile and geographically close group, neighbours might have better information about how damage has occurred and would be able to distinguish bad luck from deliberate sabotage:

> Village members have access to far better information, and therefore can self-insure as a group in a way that no formal company can replicate
> (Ray 1998):271

Continuing this information argument, Ray raises the problem of highly segmented social structures which also restrict the introduction of insurance simply because segregation is a barrier to the flow of information.

Bringing together Moser's argument that households should be supported in their attempts to buffer vulnerability and build resilient livelihoods; Chambers' observations about the biased power relations in development and the need to have complex and diverse livelihoods; and Ray's orthodox economic perspectives on risk and information flow, I will now review some of these concepts from a socio-technical systems perspective in a way that will be useful in the final analysis.

Vulnerability to risk is understood as the inability to smooth the impact of sudden changes. These risks might be idiosyncratic or aggregate. Idiosyncratic

risks affect only one place, one activity or one connection, while aggregate risks affect all places and by extension all activities and connections.

Chambers and Ray both suggest that households with 'diversity' are better able to buffer risk. For Chambers, diversity is the spreading of risk, a concept that Ray describes as having two dimensions: diversity in activity and diversity in geographic reach. A group or household that contains diversity will see all risks as idiosyncratic whereas a group which contains no diversity will experience all risks as aggregate risk.

Chambers also calls for complexity in livelihoods to reduce risk. Complexity, for Chambers, can be conceived, in its simplest form, as multiple, occasionally unnecessary, connections that create redundancy such that if a connection is broken there are back up options. Another way of understanding this, and distinguishing it from diversity, is as follows: my household buys oranges (only one, non-diverse activity) from one farmer (only one, non-diverse place). Oranges can be delivered by road, by train or by plane (multiple connections) so that even if the road is blocked or the train breaks down, oranges can still be delivered to me.

It is the difficult concept of "connection" that I consider critical to the socio-technical systems discourse. The connections that link activities and places could have any number of qualities from strength and length to density and reliability. Above, the 'length' component is incorporated into the geographic spread of diversity. Similarly, strength, density and reliability, for the purposes of this analysis, could all be understood as a function of the number of connections: a strong connection is just one way of understanding many, tightly packed identical connections.

What is missing from this description is the proposition that is raised by Borja and Castells' concept of urban hubs; Marvin and Graham's splintering process; Chambers' preoccupation with the tendency for power to reinforce itself; and van Timmeren's aristocratic networks. In all these ideas there is a possibility for the well connected preferentially to connect (or preferentially to be connected by service providers) with those that are already well connected, while the least connected remain much less well connected.

This configuration, sometimes described as clustered or non-homogenous, is an abstraction of a group in which a few members are much more connected than the rest. Returning to the earlier example of the orange supplier, this

tendency could be understood as follows: my supplier of oranges observes that I always pay my bills on time or that my orange farmer has always been reliable in the past so he arranges two trains (rather than one) to make sure oranges are delivered to me. This response takes account of three past trends: I am reliable, the farmer is reliable and the train breaks down. Farmers or orange buyers that are not reliable do not get an extra train so, even when other farmers can reliably supply oranges, their connections to consumers are unreliable. And even when other consumers urgently need to buy oranges, their connections to farmers remain unreliable.

Now, to relate notions of diversity and complexity to the notions of local and global that were introduced in Section 2.4 as part of the globalisation and cities discourse, I argue that the concept of a local group is analogous to a group without complexity and diversity: it experiences risk in the aggregate. The concept of a global group, by contrast, is a group that has diversity or complexity or both and can buffer risks, which it either experiences as idiosyncratic risks or as failures which it can tolerate through backup connections[39], in other words, by having the option to use a train, car or plane.

For urban hubs and privileged splinters to connect preferentially to each other or to be connected preferentially by service providers, the connection process must be in response to some quality or perceived quality of the hub. In its simplest, small world[40] form this quality might be the number of connections it already has: many connections are attractive. In a much more complicated socio-technical system made up of livelihood asset bundles, infrastructure connections and the potential to influence governance, I argue that this "attractiveness" is related to the perceived riskiness of the livelihood or system to be connected. If it is seen to be vulnerable, it is bypassed. This becomes self-reinforcing because in the absence of information, it is safer to assume riskiness than not. Where there is no knowledge about the bypassed, the tendency is to avoid connecting. The well connected, however, produce information about themselves through the fact of being connected. The more connected, the better able service providers are to understand their responses to risk.

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[39] This is what van Timmeren et al. argue: their 'aristocratic' networks are more resilient to random failures than the 'egalitarian' network without hubs or clusters. This will depend on how clustered the clusters are: if they cluster to the point that connections to other clusters disappear, they will lose diversity and become vulnerable to random risks again. On the other hand, the 'aristocratic' networks are more vulnerable to deliberate attack: all their eggs are in only a few baskets and if the basket is sabotaged, the damage is severe.

[40] (Albert et al. 2000):379

The final points to make here are that, firstly, the more knowledge service providers have about those they serve, the more sophisticated their response to risk, including the ability to forecast and pre-empt changes in the future. Secondly, the embedded socio-technical configurations of infrastructure and livelihoods that emerge from these responses will, to some extent, reflect past risks. The sustained ability to buffer new risks in the future, then, will probably require some sort of reconfiguration. Thirdly, if livelihoods are to enhance rather than damage the livelihoods of others, this places even more onerous requirements on a system that balances risk: there is a need to mutualise risk in new ways.

My key proposition is that these abstract concepts can be unified within a socio-technical systems perspective. My framework is constructed around two axes (Figure 12). The horizontal axis is labelled "what the powerful know" and it represents the degree to which the risks faced by individuals have been correctly quantified by the most powerful: at one end the most powerful know everything, and, at the other, they know nothing and in between they make assumptions which become more conservative when less is known. At the right hand extreme, risk cannot be quantified – the right hand space is not complex. At the left hand extreme, risk can be quantified and the response is to buffer risks by forming hubs or clusters – the left hand space is complex.

The vertical axis is labelled "how the risk is shared" and is one way of looking at the degree to which one livelihood might damage or enhance another: from risk that is individualised to risk that is mutualised. At the bottom end of the axis, risk is buffered only by a single individual with limited capacity to mitigate risk: without much diversity, each person is more vulnerable. Moving up the axis, however, individuals coalesce into households (with livelihood strategies), settlements connected by shared infrastructure and institutions and cities (within a context of shared policies, institutions and processes) until the point at which it is impossible to have a livelihood that damages the livelihoods of others. The risk sharing space can be conceived as not diverse (bottom) and diverse (top). Where risk sharing is neither diverse, nor complex, livelihoods are vulnerable (bottom right quadrant).

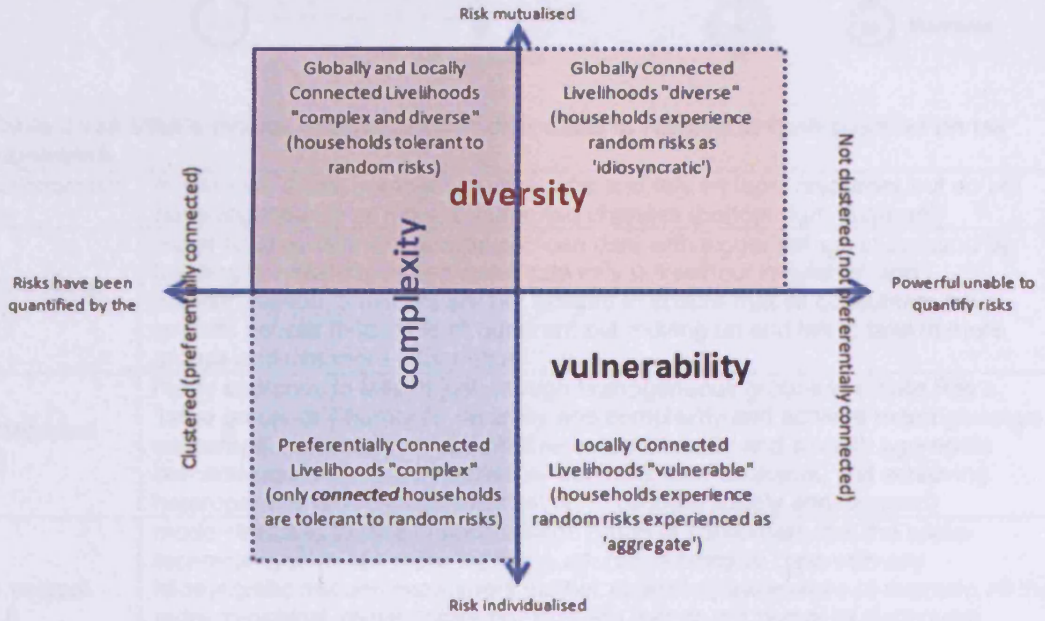
The axes intersect at a hypothetical point where the risk sharing group moves from only being able to buffer local, "idiosyncratic" risks to being able to mitigate "aggregate" risks. In the terminology of the previous section this can be

viewed as a shift from a local group (a population with everyone vulnerable to the same risks) to a global group (a population with different people vulnerable to different risks).

In Debraj Ray's "village communities", for example, where local knowledge about each household may be very sophisticated but is inaccessible to large, formal service providers that are, for example, unable to work in a participatory way, systems may be in place to share "idiosyncratic risks" but may not stretch across a large enough group to mitigate "aggregate" risks.

This is an abstract way of conceiving the links between risk sharing, modes of organising collective infrastructure and governance: it acknowledges the vulnerability context of the livelihoods framework and, at the same time, the potential power imbalance between providers and consumers of infrastructure and services, where power is understood as having both access to information and the capacity to transform it into useful knowledge for making decisions.

Figure 9 Socio-technical conceptual space: vulnerability, infrastructure and governance (Crawford 2008)



This can also be explored with reference to van Vliet et al.'s modes of organisation. Each mode can be placed in its hypothetical location in the framework as shown in Figure 10 and described in

Table 1. In addition, the framework also allows for hybrid modes or, rather, the co-existence of many different modes across the same space and the possibility of moving between spaces.

Figure 10 Socio-technical conceptual space: plotting van Vliet's modes of organisation (Crawford 2008)

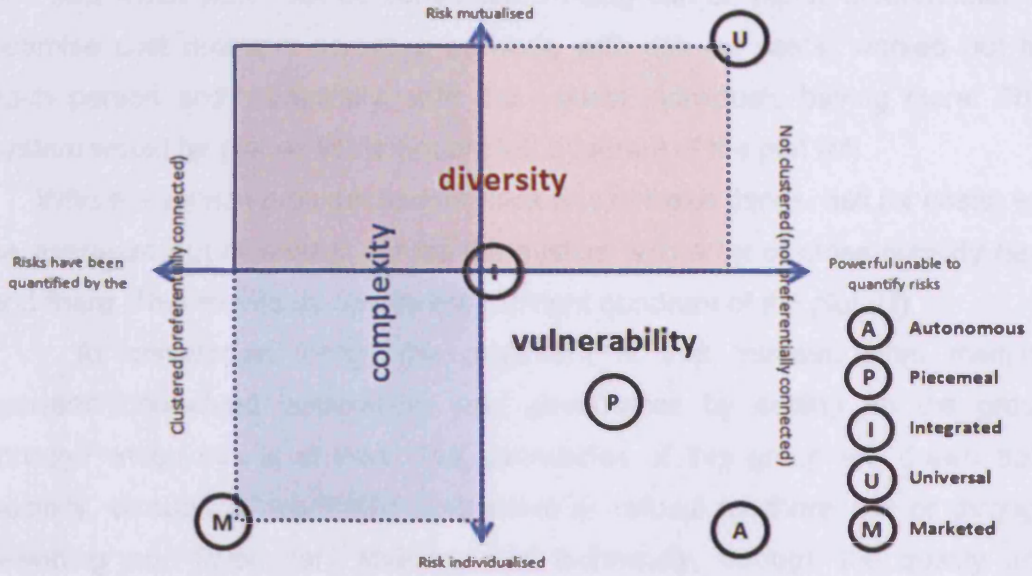


Table 2 van Vliet's modes of organisation described in relation to their position on my framework

Autonomous (A)	mode links small, homogeneous groups and rely on local resources but do not have redundancy or room to buffer big changes (bottom right quadrant)
Piecemeal (P)	mode links up different groups and can deal with bigger swings in demand by building in redundancy and spare capacity but without regulation and standardisation, providers are not obliged to ensure that all consumers have uniform access (bottom right quadrant but moving up and left to take in more groups and use more information)
Integrated (I)	mode stretches to take in just enough homogeneous groups to create Ray's 'large group' or Chambers' diversity and complexity and achieve heterogeneous consumption patterns which optimise spare capacity and smooth aggregate demand profiles (in the hypothetical centre of the framework, just achieving heterogeneity with enough information to balance supply and demand)
Universal (U)	mode stretches to take in such a large group of consumers that the socio-technical system has more than enough redundancy to cope with any idiosyncratic risk and consumers neither object to paying more to maintain all the extra-to-optimal infrastructure nor to tariffs that do not bother to distinguish between the consumption (and payment) habits of consumers (top right quadrant)
Marketed (A)	mode differentiates products and services and monitors, manipulates and matches diverse consumption habits, fragmenting socio-technical systems to meet demand and responding to savvy consumers that will pay only for what they use (bottom left quadrant)

At the bottom of the framework, whatever the mode of infrastructure provision, individuals without access to sufficiently diverse and complex asset portfolios are extremely vulnerable, while individuals with sufficiently complex

asset portfolios are in a position where they need not share risk with the vulnerable and pay only to mitigate their own risk.

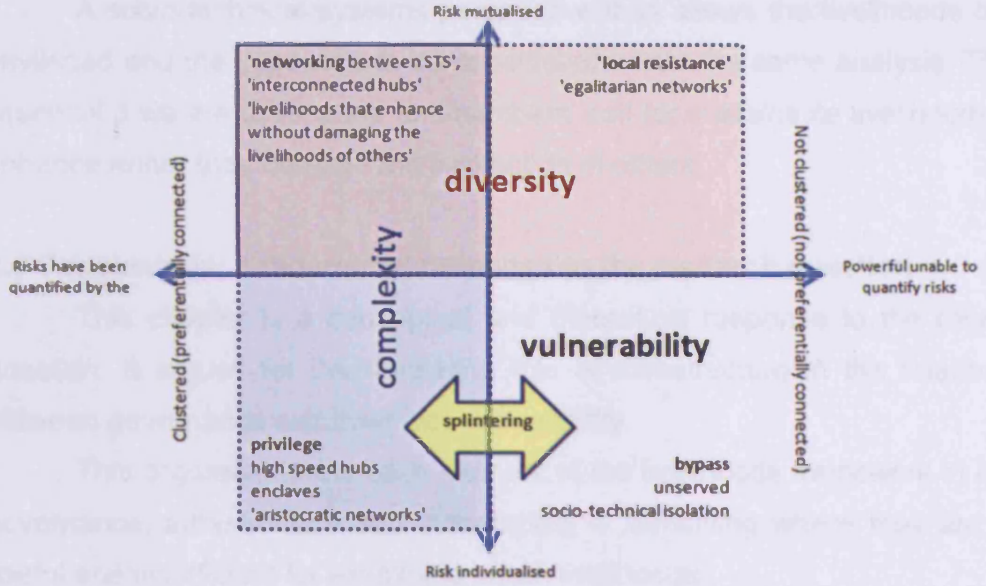
So, for example, with the example of a water provider, there might be, at one exaggerated extreme, a provider that knows exactly how much each household is able to pay for water, how timely payment will be and exactly when and how much water will be consumed. Pricing can be highly differentiated to optimise cost recovery across a network, with risk (or costs) worked out for each person and, potentially, with the riskiest individuals paying more. This system would be placed in the bottom left quadrant of the plot (M).

Where a service provider cannot track any of these things, risk (or costs) will be averaged out or shared across the system with a bit of cross-subsidy here and there. This moves us up into the top right quadrant of the plot (U).

In conceptual terms, the argument is that infrastructures mediate between household vulnerability and governance by setting up the group through which risk is shared. The boundaries of this group are drawn both socially, through a negotiated agreement or refusal to share risk or through unwitting and involuntary sharing, and technically, through the quality and extent of infrastructure. I argue, therefore, that risk is shared through what I have already described as socio-technical systems.

Critically, this framework also permits a re-examination of the socio-technical systems perspective in terms of vulnerability and governance. The processes of privilege and bypass described in Marvin & Graham's splintering urbanism thesis can be hypothesised in relation to the framework as shown in Figure 11.

Figure 11 Socio-technical conceptual space: plotting Marvin and Graham's splintering (Crawford 2008)



Privilege is part of the dynamic that moves towards a marketed mode of organisation in the bottom left quadrant, with powerful service providers motivated (arguably by powerful consumers) to apportion provision and costs according to the risks presented by individual livelihoods. Although risk is individualised for everyone, the privileged, understood as people with complex (interconnected) livelihood assets, are still able to buffer risk. Meanwhile, as the process of privilege consolidates itself, the groups that are left without services find themselves with modes of organisation in the bottom right quadrant, bypassed by the socio-technical systems that would allow them to buffer risk. Service providers continue to collect information, and information about privileged or connected users becomes continuously better than information about the bypassed; service providers continue to quantify risk based on this information, thus the riskiness is higher for those already bypassed or in places where lack of information makes risk harder to quantify.

The key point here is the interaction of livelihood assets and vulnerability. The diverse and complex livelihood portfolios that allow the privileged to buffer risk or make the bypassed vulnerable cannot be understood as something contained within an individual or a household as the livelihoods framework starts to suggest. Diversity is seen, in this thesis, as a stretched socio-technical system that connects a household's assets to other places, while complexity is seen as the link between household assets and other highly interconnected livelihoods, pieces of infrastructure or institutions.

A socio-technical systems perspective thus allows the livelihoods of the privileged and the bypassed to be considered within the same analysis. This is essential if we are to respond to Chambers' call for sustainable livelihoods that enhance rather than damage the livelihoods of others.

2.6 Conclusions: a theoretical response to the research question

This chapter is a conceptual and theoretical response to the research question. It argues for the mediating role of infrastructure in the relationship between governance and livelihood vulnerability.

This argument treats each element of the livelihoods framework in turn – governance, infrastructure and vulnerability – identifying where they are both useful and insufficient for examining urban livelihoods.

In conceptual terms, the governance framework identifies three groups of actors but overlooks the tendency for access to power and infrastructure to frame the activities of each of these groups. Next, the provision of infrastructure in cities is understood in terms of the governance framework. Since this does not explain well the patchy provision of infrastructure in cities, I turn to the argument that the global economic and telecommunications connections of cities are instrumental in shaping the social and spatial distribution of urban services. Build on this perspective but challenging the tendency to attribute all urban activity to a city's place in a global system, I turn to a more interconnected socio-technical systems perspective. This conceives infrastructures in cities as a relationship between physical and environmental hardware and institutional social, economic and political: these relationships as we have configured them for this century are giving rise to a splintering process.

Finally, livelihood vulnerability and the mitigation of risk are explored in light of the governance and infrastructure discourse. I bring these ideas together in a framework which explores how all three interact to influence vulnerability, the mode of organisation through which infrastructure is produced and consumed and splintering. I argue that to use the Sustainable Livelihoods framework to describe livelihoods which enhance rather than damage the livelihoods of others means sliding between the different quadrants in my model. More importantly, to attain the Sustainable Livelihoods conceived by Robert Chambers, will imply an informed and willing reconfiguration of infrastructures that allows negotiated and institutionalised mutuality.

In the next chapter, I tackle the second stage of the thesis: developing a methodological approach which can capture the socio-technical systems operating in Cusco.

Chapter 3 Formulating a Research Methodology

This chapter responds to the second sub-question posed in the introduction by developing a methodological approach. Following on from the concepts introduced in Chapter 2, the methodology is designed to unpick the role of socio-technical systems as a mediator between governance and vulnerability through the empirical case study of Cusco.

Just as the conceptual starting point of the thesis was the sustainable livelihoods framework, so the methodological basis of the research is this framework's analytical categories and research techniques. This chapter describes the application of qualitative and quantitative methods to each component of the livelihoods framework and develops mixed and visual tools for conceptualising socio-technical systems as they play out in the household experience of Cusco's water and sanitation infrastructure.

It is worth remembering that the framework's categories and techniques are the outcome of many years of participatory and action-oriented research and are not intended to be prescriptive. With this in mind, this research is founded on participation and the use of carefully selected case studies to explore the rich interconnections between livelihoods, governance and infrastructure.

Leading on from this methodological outline, Chapter 4 begins with a short introduction to Peruvian policies, institutions and processes by offering a discursive analysis of the country's national and local governance. Similarly, the infrastructure and services component of the sustainable livelihoods framework is first introduced in terms of the role of the Peruvian state, markets and civil society.

This analysis guides the selection of three case studies in Cusco which represent different aspects of urban water and sanitation provision in Peru: San Blas, in Cusco's historic centre, served by the provincial water authority; Angostura, a settlement on the edge of the city served by a community-managed system; and Manco Capac, a zone, in the heart of the city, served by a separate community-built, committee-managed water provider.

The livelihoods and vulnerability of households in these three places are then analysed case by case in Chapters 5, 6 and 7. This part of the thesis concludes with Chapter 8, a final, comparative summary of all three case studies in terms of access to household assets, infrastructure and influence.

Chapter 9 then returns to the configuration of socio-technical systems in Cusco, using the governance and vulnerability context to explain the qualitative and quantitative features of water and sanitation, its distribution across the city and its role in mediating vulnerability. This brings the argument back to the socio-technical conceptual space developed in Chapter 2.

3.1 Applying the Sustainable Livelihoods framework

The research question concerns relationships between and within households as well as between and within infrastructure systems and institutions, it lends itself, therefore, to a methodology that is able to capture rich and sometimes unanticipated data. In these situations it is necessary to adopt approaches which allow participation between householders or community groups, open-ended interview techniques and qualitative and interpretive accounts of what is happening. Add to this the practical constraints of time, money and climate[41] and it is clear that the research methodology must be pragmatic, in that it makes some initial empirical assumptions, as well as flexible and adaptable to the context in Cusco. The sustainable livelihoods framework has emerged from participatory studies that have faced these challenges again and again and it thus provides a practical starting point.

The sustainable livelihoods approach offers a range of tools including the use of case studies, key informant interviews, workshops, household interviews, profiling, participatory mapping techniques and analysis of secondary sources (DFID 1999;Rakodi 2002b;Rakodi 2002c). The methodology is necessarily mixed and calls for the use of research techniques from different disciplines, combining qualitative and quantitative methods, thematic analysis of primary and secondary sources and processes of triangulation or cross-referencing as a check on validity[42]. The data analysis in the following chapters adopts the framework's analytical categories to organize themes and findings beginning with policies, institutions and processes in Peru and Cusco and then moving to

[41] The fieldwork took place over the course of 2006-7 with key informant interviews taking place throughout. The first quarter was taken up with a local literature review, field visits and preliminary interviews. The second quarter saw the dry season water sampling programme followed by in-depth household interviews in the third quarter and wet season water sampling in the final quarter.

[42] Robert Chambers offers two tests for validity as trustworthiness, the quality of being believable as a representation of reality, and relevance, the practical utility for learning and action. For guidance on what is expected see the writers who have grappled with this theme (Boyatzis 1998) (Chambers 1997) (Durrheim & Terre Blanche 1999) (Gill 1993)

livelihood assets, strategies, vulnerability context and governance in three case studies. These categories were fleshed out using the following qualitative and quantitative techniques.

3.2 Data collection I: understanding livelihoods

The process of identifying key informants and case studies was part of a broader Peruvian literature review – outlined in the following chapter - and accompanied by preliminary meetings and interviews in Lima and Cusco. Through this research, institutions and actors in Cusco's governance and infrastructure were gradually identified.

Key informant interviews were conducted with the individuals and groups listed in the tables below (Tables 2 and 3). I conducted all interviews in Spanish and the structure was based on a SWOT analysis. The basic tool is reproduced in Appendix B. These were supplemented by observation and participation in workshops and meetings throughout the research.

Table 3 Key Informants: whole city

Case Study	Organisation	Position	Name	Date
All	SEDACusco	CEO	David Valenzuela	24-4-2006
All	SEDACusco	Operations	Lita Allende	2-6-2006
All	SEDACusco	Santa Ana Plant Manager	Ing. Franklin Perez Ruibel Rodriguez	15-12-2006
All	SEDACusco	San Jeronimo Plant Team	Rocío Venero	20-12-2006
All	SEDACusco	Operations	Ing. Flores Gorky	12-2-2007
All	SUNASS	Director	Patricia Concha Flores	5-4-2006
All	Centro Guaman Poma de Ayala	Team Leader	Justo Pastor Vargas Sota	12-4-2006
All	Centro Guaman Poma de Ayala	Team Leader	Justo Pastor Vargas Sota	6-62006
All	Centro Guaman Poma de Ayala	Southern Valley Team	Justo Pastor Vargas Sota, Gustavo Salazar, Oscar Casas	14-6-2006
All	Centro Guaman Poma de Ayala	GIHR Team	Rinske Warner, Lizardo Holgado, Oscar Casas	8-7-2006
All	Centro Guaman Poma de Ayala	O&M Workshop	The Southern Valley Fontaneros, Justo Pastor Vargas Sota, Lizardo Holgado, Oscar Casas	25-7-2006
All	Centro Guaman Poma de Ayala	Historic Centre Team	Sachenca Ardiles	26-7-2006
All	Centro Guaman Poma de Ayala	Directors	Nicole Bernex; Jose Maria Gomez	4-4-2006
All	IMA	Vilcanota Committee	José Casteñada, Luis Jimenez, Amelia del Mar	26-6-2006

Table 4 Key Informants: case studies

Case Study	Organisation	Position	Name	Date
Angostura	Angostura Committee	Angostura Committee President	Olimpia Carpio	24-11-2006
Manco Capac	ASAPASC	Administrator	Nemecio Calsino	30-6-2006
Manco Capac	ASAPASC	Maintenance Team	Anon.	30-6-2006
Manco Capac	ASAPASC	Board Meeting	Board Members	10-6-2006
Manco Capac	Centro de Salud Manco Capac	Physician	Dr Eduardo Cosme	6-6-2006
San Blas	Centro Guaman Poma de Ayala	Southern Valley Public Workshop	Nicole Bernex	4-4-2006
Manco Capac	Municipality of Santiago	Mayor of Santiago	Jose Luis Aguirre Navarro	14-2-2007
Angostura	Municipality of Saylla	Mayor of Saylla	Edwin David Cahuana Kana	19-2-2006
Manco Capac	World Vision	Team Leader	Fidel Guzman	6-6-2006

Participatory exercises[43], listed in Table 5, were organised in each case study site with the help of local committees. Since there was no funded "project" behind the participation sessions, the meetings were ostensibly convened to present the results of water sampling, thank households and solicit the views of community members outside the sampled groups. This exercise was extremely successful in Angostura. By contrast, after two formal attempts in Manco Capac, I resorted to setting up a stand on a main street corner to talk to residents.

Table 5 Participatory sessions

Case Study	Position	Date
Angostura	Angostura Community Meeting	18-2-2007
Manco Capac	Manco Capac Community Meeting	10-2-2007, 14-2-2007, 17-2-2007
San Blas	San Blas Community Meeting	17-2-2007

Household sampling was purposive with the intention of representing the "best off", the "worst off" and the "typical" households in the zone, as understood by gate keepers and key informants. The households were also

[43] The SL framework is used to engage people in their own development through participation. This is an academic research project not a development project and this highlights a tension between "extractive" post-graduate research and genuine participation. To overcome this problem, the proposal of Anna Lawrence, writing on participatory research on biodiversity in Latin America and elsewhere, has been to avoid splitting research into the "pure" participation favoured by Robert Chambers, and other, more mixed modes of research from the "instrumental" to the "transformative" (Lawrence 2006)283:287. In my research, the SL framework is instrumental in guiding 'extractive' research – populating the analytical categories with data – while the participatory, 'transformative' content of the livelihoods approach is built in to every encounter with participants and key informants using formal and informal opportunities to build trust

selected so that they were distributed across the zone's water network rather than clustered around a single node or water main. Several visits were made to households before and after the main interviews to arrange appointments for subsequent meetings, to take water samples and to get past the initial barrier of being a stranger. Each formal meeting then took between forty minutes and an hour and forty-five minutes and although the questions were principally designed to probe the household's livelihood assets, strategies and surrounding governance structures, they were open-ended. The responses were used to develop an account of livelihoods that would be both useful for comparison beyond the household and unconstrained enough to allow the particular and personal perceptions of householders to come through. Within the skeletal category headings of the livelihoods framework there is room to manoeuvre and describe, allowing a treatment of data that can evoke and frame each case study and give qualitative views alongside simple, quantitative graphical and visual representations. The in-depth interviews thus lie somewhere between a household biography and a questionnaire. I conducted Interviews in Spanish in fifteen[44] households in each case study area. Interview formats were built around the analytical categories set out in the Sustainable Livelihoods framework shown in Figure 11.

The final tool, held in Appendix C, was trialled with colleagues from the University San Antonio of Abad Cusco (UNSAAC), specialists from the Centro Guaman Poma de Ayala and World Vision, laboratory assistants and two Spanish teachers. This led to a significant re-ordering of the format away from a sequence that followed the livelihood categories and towards an order that proved much more intuitive during testing. This format – but not the substance of the questions – was modified once more after initial interviews so that the conversations with participants flowed more smoothly. The final design included an opening section that was taken directly from the Peruvian census. This was done to locate each household in the context of secondary census data and because it seemed to put people at ease, perhaps because the questions were

[44] Small, purposive samples are the appropriate choice for this qualitative livelihoods methodology. Non-probability sampling for case studies and households was applied according to criteria of accessibility and convenience : travel times between each location and the laboratory less than an hour in order to get samples back to the lab in reasonable time and ensure personal safety by returning to the lab before dark; locations accessible by public transport or taxi; and locations safe for me to work alone based on the advice from local contacts, personal judgement and the availability of mobile phone reception.

seen as 'easy' to answer since they had been rehearsed during the national census in 2005.

The following tables offer definitions of each analytical category and the tools and sources used to probe them (Rakodi 2002b). The data generated include a mixture of quantitative indicators and qualitative characteristics that go towards building up a picture of livelihoods.

Households are referred to by a number between 1 and 45. The households sampled in San Blas cover HH16 to HH30, in Angostura HH1-HH15 and in Manco Capac, HH31-HH45.

Table 6 Examples of Livelihood Assets and Strategies, Tools and Data Generated

Livelihood Assets: *access to assets*			
		Tools and Sources	**Data Produced**
Human Capital	number of household members, time for income-earning activities, levels of educations, skills and health status	Household interviews	sex, age, job, education level and relationship to head of household, household repairs, illness related to water, household treatment of water
Natural Capital	Natural resource stocks useful to livelihoods: land, water, common pool resources	Household interviews	land and livestock ownership, irrigation sources, alternative sources of drinking water, household fuel sources
Financial Capital	Available financial resources for livelihoods (credit, savings, pensions, remittances, rental income)	Household interviews	wage of each person per day/month/harvest, tendency of wages to vary, cost of alternative water sources, utility bills
Physical Capital	Basic infrastructure (transport, shelter, water, energy, communications) and production equipment for livelihoods.	Household interviews, observation	house ownership, number of rooms, number of bedrooms, type of water connection, number of taps, patio drainage, type of WC connection, predominant material in roof, external walls, flooring, patio, photograph of tap, sanitary risk assessment
Social Capital	Social networks, membership of groups, relationships of trust and reciprocity, access to wider institutions of society exploited in pursuit of livelihoods	Household interviews	number of years in neighbourhood/present house, alternative sources of water and help when services fail, sources of help in the face of hazards
Livelihood strategies and opportunities			
Interaction of household assets and context; activities; responses to risk; investment in assets; substitution of assets; livelihood decisions		Household interviews, workshops	land cultivation, livestock rearing for sale/domestic consumption, reasons for variation in incomes, uses of household water supplies, household storage, response to hazards, response to insecurity

Table 7 Examples of Vulnerability Context, Tools and Data Generated

Vulnerability Context		
	Tools and Sources	**Data Produced**
Location of with respect to topography, flood prone areas; slopes and hillsides; contaminated areas; dump sites; access to green space; traffic and safety.	Household interviews, workshops	natural hazards (frequency and duration), power cuts (frequency and duration), insecurity, priorities for change
Occurrence, intensity and duration of hazards (flooding, earthquakes, crime, power cuts). Nature and origin of neighbourhood associations;	Secondary data (census)	sex, age, education level and relationship to head of household, illness related to water
External assistance and relief activities; Impact of external shocks on households; Coping mechanisms (diversification of livelihood strategies, migration);	Secondary data (census)	predominant material in roof, external walls, flooring, type of household connection
Composition of households, population density; Macro-economic trends;	Key informant interviews	people helping when services fail or hazards occur
Urban economic base and activity mix; employment and cost of living (inflation) trends; Policies and attitudes towards informal sector activity; micro finance practices	Secondary sources (government and company reports, research, documentation)	**Shocks, Trends and Seasonality:** climate, environmental data, local economy

Table 8 Examples of Infrastructure and Services, Tools and Data Generated

Infrastructure and Services: *access to infrastructure*		
	Tools and Sources	**Data Produced**
Adequate water and sanitation infrastructure (coverage, continuity, quality, quantity, affordability); Roads and transport; Markets; Energy infrastructure; Education, health and social services;	Household interviews, workshops	interruptions in services, household views on services (availability, costs and meters), changes in services over time, waste services, disposal of waste and waste water, nearest schools, health posts, bus stops
	Key informant interviews	interruptions in services, providers' views on services (availability, costs and meters), changes in services over time, waste services, disposal of waste and waste water, Strengths, Weaknesses, Opportunities, Threats, vision, funding, costs
	Secondary sources and institutional analysis (government and company reports, research, documentation)	roles of key actors in service provision, municipalities, regulators, NGOs; organigrams and constitutions; legal frameworks, remit, extent, scope, scale;

Table 9 Examples of Governance, Tools and Data Generated

Policies, institutions and processes: *access to influence*		
	Tools and Sources	**Data Produced**
Governance: Structures, Organisations, Processes (laws, policies, cultures, institutions); actors from government, civil society and market; Presence and importance of community level institutions; Interaction of population with external organizations; Control of resources by organizations;	Household interviews, workshops	active NGOs, membership of organisations, level of participation (board member, attendance at meetings and work days, voting, payment), organisations providing services, organisations helping when services fail or hazards occur, attitudes to municipal, regional and national government, private sector organizations
Formal versus informal institutions and organizations; Ethnicity; religion and gender; Urbanisation patterns; Political parties; access to voting; Feelings of insecurity/uncertainty at household and community level; Informal controls through gangs/'mafias' etc;	Key informant interviews	organisations providing services or linkages to governance entities **(aggregate Social Capital)**
Police harassment; other harassment by state or informal structures. Impact of rules, regulations and policies on households, and communities; Access to identification documents; taxation (formal and informal); tenancy laws; regulations on 'hawking;' influence of zoning	Secondary sources and institutional analysis (government and company reports, research, documentation)	roles of key actors from government, civil society and government, NGOs; organigrams and constitutions; legal frameworks, remit, extent, scope, scale;

3.3 Data analysis I: visualising livelihoods

In the chapters that follow, households are grouped according to their livelihood strategies and outcomes. The first stage of this categorisation is supported by graphical asset pentagons. To construct these diagrams, proxy indicators for each capital were developed from the interview framework above and are summarised[45] in Table 9.

[45] Based on early key informant interviews and field visits in Cusco as well as the body of work referenced in Chapter 2

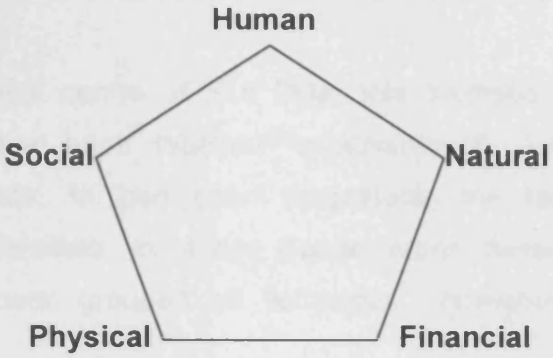
Table 10 Summary of indicators used to quantify assets

		Strong Asset Score: 1.00	0.75	0.50	0.25	Weak Asset Score: 0.00
Human	% household economically active	81-100%	61-80%	41-60%	21-40%	0-20%
	Education level of head of household	Completed university or tertiary	univ/higher incomplete	secondary complete	secondary incomplete	primary or less
	highest education level in household	Completed university or tertiary	univ/higher incomplete	secondary complete	secondary incomplete	primary or less
Natural	land ownership	Owned land		rented land		none
	Irrigation type	Rain/spring		Huatanay water		none
	fuel type used for cooking	Electricity	Gas		Other	wood
	household production (livestock)	for sale and household consumption		household consumption only		none
	household production (crops)	high growing only	high and low	low only	grass only	none
Financial	most secure household salary type	Monthly		weekly	Daily or by harvest	daily or by harvest
	Income bracket	400+	300-399	200-299	100-199	0-99
	rental income	150+	100-149	50-99	1-49	0
	water service cost as a % of income per capita	0-2%	3-5%	6-8%	9-11%	11+%
Physical	Home ownership	bought or inherited	By occupation		mortgaged	rented
	Occupants per room	>2	2-4	4-6	6-8	8+
	Roofing	reinforced concrete	Tiles	CGI	wood	straw/mud
	Walling	brick or block	stone + cement mortar	adobe	stone mud mortar	straw/mud
	Flooring	parquet or polished wood	linoleum	flags/tiles	cement	earth
	Patio surface	Cement and drainage	cement no drainage		earth + drainage	earth no drainage
	Tap drainage	Concrete sink	stone sink		direct onto drained patio	direct undrained patio
	Tap type	Encased				standpipe
	Tap condition	v good	good	reasonable	poor	bad
	Hose condition	v good	good	reasonable	poor	bad
Social	Time in barrio	>10 years	10-19.99	20-29.99	30-39.99	40+ years
	Level of participation	membership, attendance, voting		membership or voting or attendance or combo		no membership, voting or attendance
	Payment of fines or subscriptions	Fines		subs		Nothing

These indicators were scored between 0, a weak asset, and 1, a strong asset. An average asset score was worked out for each category of household capital: human, natural, financial, physical and social. These scores were then used to plot an asset pentagon as a visual summary for each case study (Figure 22). The plots offer a comparison between zones as well as a picture of

the differences within zones and between households. Since the sampling method deliberately sought out the best and worst off in each case study area, the spread of households on each axis of the plot is not to be understood as a statistical range but as a way of understanding the heterogeneity of households and the relationship between this and their vulnerability.

Figure 12 Sustainable Livelihoods Asset Pentagon



As an example, the asset base for a single household is interpreted below in Figure 21.

Figure 13 Examples of asset pentagon forms

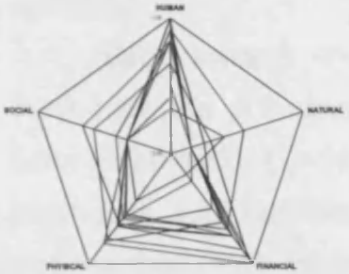
Household assets, consistently strong along all axes for all capitals

Household assets, consistent but weak across capitals

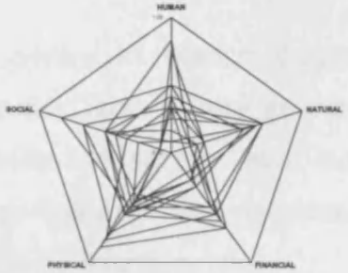
Asset bundle with only one strong asset (in this case Human Capital)

Figure 14 Asset Pentagons for San Blas, Angostura and Manco Capac

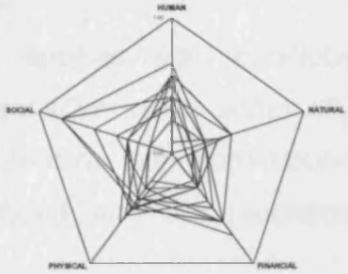
San Blas



Angostura



Manco Capac



The second stage of the process, designed to capture the similarities and differences between household livelihoods within the same case study site, was

to group households according to their livelihood assets, strategies and outcomes. This process of profiling is essentially a painstaking qualitative and thematic analysis of the household interview results, devised to extract the dominant strategies and outcomes in each location. It groups households with similar strategies and outcomes and splits them into three groups according to the tendencies which differentiate them. The analysis looks for patterns in household asset bundles, livelihood activities which affect the ability to buffer shocks and stresses and interaction with the institutions and processes of governance.

In the historical centre of San Blas, this thematic analysis generated categories that have been labelled 'establishment', 'entrepreneurial' and 'excluded' livelihoods. In peri-urban Angostura, the labels are 'urbane', 'traditional' and 'diversified'. In Manco Capac, much closer to the centre, the households have been grouped as 'tenacious', 'homebound' and 'landlord' livelihoods.

By examining households according to these groups, it is also possible to look at the interdependence of their livelihoods. Establishment livelihoods in San Blas tend to derive income from formal sector, professional jobs while households in the entrepreneurial group serve tourists or look towards markets abroad. In the excluded category, livelihoods are linked to local food markets, street selling or seasonal construction work.

In Angostura, families with traditional livelihoods produce their own food and also supply food back to markets in the city. Others with diversified livelihoods are involved in urban transport, going between the centre and the edge of town. The urbane livelihoods are connected to government projects, local politics and consultancy but also tend to keep livestock and organise local activities.

Back towards the centre in Manco Capac, families with tenacious livelihoods are providing public and private sector services to the wider city often in precarious industries like construction. Households with homebound livelihoods run businesses serving the neighbourhood and the landlords stabilise their family incomes by letting rooms.

In each case study, the importance of water and sanitation services to livelihoods is tested through questions on family health, the volumes of water consumed at home and the household uses of water, the irrigation of land, the

cost of water, alternative water sources and broader questions on water and waste in the environment.

Vulnerability Context, Infrastructure and Services and Governance are analysed with reference to the livelihood profiles established for each case study. This analysis allows and examination of aspects of vulnerability that are 'blind' to livelihood or that impact on certain livelihoods more than others. A good example in Cusco is the solid waste collection service. This is the responsibility of district municipalities but when the service is inadequate, it is often worse in certain patches of the district – perhaps those furthest from main roads – such that all households in that patch tend to be affected in similar ways, regardless of individual household assets and strategies.

Throughout the case study chapters, there is a strong emphasis on the assets and vulnerability that are related to water and sanitation infrastructure.

3.4 Data collection II: understanding Socio-Technical Systems using the WHO indicators

A picture of socio-technical configuration is built up in two stages starting with an evaluation both of household connections and whole water systems in each case study. This evaluation is based on the World Health Organisation's guidelines for the safety of drinking water supplies. The second component of the analysis is a discussion of the interaction of governance an infrastructure through a description of each provider's mode of organisation and an assessment of socio-technical scale in the context of neighbouring providers (see Table 1).

After van Vliet et al., scale is seen in this research as both social and technical: a function of engagement with other entities in the governance framework including providers, municipal authorities, NGOs and communities; the number of users; the rate of drinking water production and; the spatial extent of the system.

The WHO methodology comes with a valuable toolkit of tests, surveys and a quantitative diagnostic summary of five water-supply service parameters: quality, quantity, continuity, affordability, accessibility (summarised in Table 10). In addition to these parameters, a further indicator, disposal method, has been added to describe what happens to waste water once it leaves households.

Table 11 WHO service parameters (summarised from World Health Organization 2006)

Quality: based on a sanitary risk assessment

Quantity: the proportion of the population using water from different levels of drinking-water supply (e.g., no access, basic access, intermediate access and optimal access) as a function of service level and quantity of water collected

Service level	Distance/time	Likely volumes of water collected	Public health risk from poor hygiene	Intervention priority and actions
No access	More than 1km or more than 30 min round-trip	Very low - 5l/capita/day	Very high: hygiene practice compromised; basic consumption may be compromised	Very high Provision of basic level of service Hygiene education
Basic access	Within 1km or within 30min round-trip	Average approximately 20l/capita/day	High: hygiene may be compromised; laundry may occur off-plot	High Hygiene education Provision of improved level of service
Intermediate access	Water provided on-plot through at least one tap (yard level)	Average approximately 50l/capita/day	Low: hygiene should not be compromised; laundry likely to occur on-plot	Low: hygiene promotion still yields health gains; encourage optimal access
Optimal access	Supply of water through multiple taps within the house	Average 100-200l/capita/day	Very low: hygiene should not be compromised; laundry will occur on-plot	Very low: hygiene promotion still yields health gains

Accessibility: the percentage of the population that has reasonable access to an improved drinking-water supply, where improved water supply technologies include a household connection; public standpipe; borehole; protected dug well; protected spring; rainwater collection. On this scheme unimproved supplies originate at an unprotected well; unprotected spring; vendor-provided water; bottled water; tanker truck provision of water.

Continuity: the percentage of the time during which drinking-water is available (daily, weekly and seasonally). Types and causes of discontinuity are graded by their increasing severity as shown below:

	Type of continuity
1	Year-round service from a reliable source with no interruption of flow at the tap or source
2	Year-round service with frequent (daily or weekly) interruptions
3	Seasonal service variation resulting from source fluctuation
4	Compounded frequent and seasonal discontinuity.

Affordability: the tariff paid by domestic consumers.

In this research, the WHO approach has been applied to the household connection as well as to the whole system. Applying the service parameters to household connections is one way of valuing the elements of infrastructure that appear in household asset bundles. The socio-technical configuration of infrastructure affects the value of household assets and, particularly in the case of Physical and Social Capital, these household assets feedback and affect configuration. For example, poor physical assets, like a muddy, un-drained patio,

increase sanitary risk and indicate low quality, while weak social capital may reduce the potential to "borrow" water from elsewhere thus affecting quantity. Table 11 shows how the WHO indicators are implicated across the livelihood capitals.

Table 12 Mapping WHO indicators to household capital assets (Crawford 2008)

Capital	WHO Indicator	Possible impact of capital on indicators OR indicators on capital	Related interview questions
Human Capital	quality quantity continuity accessibility affordability	health and the ability to work or study	Has your family ever had an illness because of the water? Do you drink water direct from the tap/boiled/other?
Natural Capital	quantity continuity *disposal*	home-based income generation like plants and livestock	What do you use water for apart from drinking, cooking, washing, cleaning and family laundry? Do you get water from anywhere else apart from your own tap?
Financial Capital	quality quantity continuity accessibility affordability	household expenditure on bills or other water sources, home-based income generation like food production, laundry and letting rooms	Do you get water from anywhere else apart from your own tap? What do you use water for apart from drinking, cooking, washing, cleaning and family laundry? Bills as a % of income
Physical Capital	continuity accessibility *disposal*	improved household connections and value of home as an asset	sanitary risk assessment, water sampling, photographs of installations
Social Capital	quality quantity continuity accessibility affordability	interaction with neighbours to borrow/buy water or act collectively to improve water system	Do you get water from anywhere else apart from your own tap? What do you do and who helps if the water stops?

The **quantity** indicator is defined with reference to a household's "access level": a function of the distance to water points, likely volumes of water collected and public health risks from poor hygiene. As shown in Table 10, the guidelines suggest a range from *no access,* a 30 minute round trip to collect water and a daily consumption of less than 5 litres per capita, to *optimal access*, multiple household taps and a corresponding water consumption of 100 to 200 litres per capita per day.

In the livelihoods chapters that follow, these categories are useful for showing that levels of household access and consumption vary even when households are ostensibly connected to the same piped systems. At the same

time, the livelihood interviews provide an opportunity to ask householders directly how much water they think they use.

Continuity and **affordability** are perhaps the most straightforward of the indicators and can be cross-checked between households, key informant interviews and direct observation. The water tariff in isolation, however, does not indicate affordability. It has to be seen in the context of household livelihoods and is shown in a comparison of income and bills in Chapters 4 to 6 and again in an overall cost comparison in Chapter 7.

Accessibility is concerned with whether household access is "improved" where a piped household connection is considered to be "improved". In the case studies, because of intermittent supply, several households are forced to collect water from "unimproved" sources. Accessibility is captured using a sanitary risk assessment, accounts of alternative water sources and photographs of household connections: "improved" principal taps and their surrounding unimproved paraphernalia.

3.5 Data analysis II: visualising Socio-Technical Systems

What makes the WHO tools useful for understanding water **quality** is that they are based on managing risk; a concept invoked to cope with unknowns that cannot be easily, routinely or pre-emptively measured. With by now familiar resonance with the Socio-Technical Systems approach, this risk has a social dimension (the foibles of the water governance arrangement) and a technical dimension (the state of the pipes and plant). High quality water, for example, would be expected from a provider that had in place a Water Safety Plan and audits that had been approved and validated according to WHO requirements. In the absence of this documentation, quality at the whole system level is based on sanitary risks scores for the source and supply systems and a system inventory which identifies potential hazards: the points in a system that are susceptible to faecal contamination.

In this study, the inventories and risk scores and disposal characteristics are fused into a colour-coded flow chart that shows the highest thermotolerant coliform counts identified during sampling. Household level quality complements the system analysis with sanitary risk assessments comparing the levels of

residual chlorine and thermotolerant coliforms in households across the case studies.

Water sampling was conducted in the same fifteen households as the interviews in order to relate the water in individual houses to each livelihood assessment (not as a network monitoring exercise). The aim was to generate a reliable snapshot of drinking water in the morning, at midday and in the afternoon on a single day[46]. To achieve this within the timeframe, samples were taken from 2-3 houses each day, once during the wet season (July and August 2006) and once during the dry season (January and February 2007)[47]. The combined results of bacteriological tests and sanitary risk assessments have been plotted for each household and each system as part of a comparative analysis of quality and are presented in the case study chapters and Chapter 7, the configuration chapter.

The system for scoring sanitary risk uses a checklist of ten appropriate questions. Answering "yes" to any of the questions scores 1. The score is summed and given out of ten, with 0 representing low risk and 10 representing a high risk. An example is shown in Table 13 and the remaining checklists are held in Appendix D.

Table 13 Checklist for a protected spring source (Angostura and Manco Capac)

1	Is the spring source unprotected by masonry or concrete wall or spring box and therefore open to surface contamination?
2	Is the masonry protecting the spring source faulty?
3	If there is a spring box, is there an unsanitary inspection cover in the masonry?
4	Is the area around the spring unfenced?
5	Can animals have access to within 10 m of the spring source?
6	Are there any latrines uphill of the spring?
7	Is spring water combined with surface sources before treatment?
8	If there is a filter, is it functioning badly?
9	Is the flow uncontrolled?
10	Is chlorination unavailable or unreliable?

The classification of sanitary risk scores is shown in Table 13. These scores are then plotted against the highest thermotolerant coliform counts found

[46] Sampling in the purposive household sample and at the source, storage and treatment systems during the Andean seasons of abundant and scarce rainfall were designed to catch the worst moments of contamination: "Verification of microbial quality of water in supply must be designed to ensure the best possible chance of detecting contamination. Sampling should therefore account for potential variations of water quality in distribution. This will normally mean taking account of locations and of times of increased likelihood of contamination." (World Health Organization 2006):72.

[47] Where tap water was not available, samples of water stored were taken. Where water was extremely scarce, single samples were taken from buckets because it became obvious that householders were anxious about losing water to the research process.

the system, sampled at its most risk prone points. This classification of coliform counts is shown in Table 15. The final plot locates each household or whole system on a grid like the one in Figure 23 below.

Table 14 Risk classification of sanitary scores

Sanitary risk score	Risk* Classification
0	No observed risk
1 to 3	Low risk
4 to 6	Intermediate risk
7 to 10	High risk

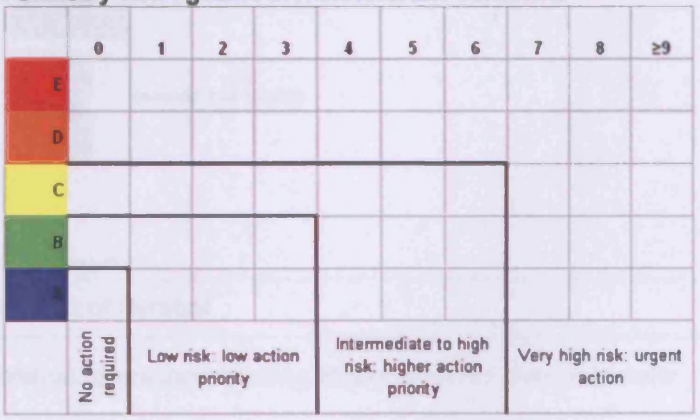
* Where "[t]he term "risk" as used here indicates potential danger to human health from a water source or supply." Adapted from Table 5.1 (World Health Organization 2006):77.

Table 15 Classification of thermotolerant coliform counts

TTC count	Colour Code
0	A
1 to 10	B
10 to 100	C
100 to 1000	D
>1000	E

TTC = Thermotolerant Coliform
Adapted from Table 5.2 (World Health Organization 2006):78

Figure 15 Plot of sanitary risk against thermotolerant coliforms



Finally, Figure 24 shows an example of the resulting colour-coded system inventory flow chart. The flowchart uses classic process flow symbols reproduced in Table 15 and the points at which risks enter the system are highlighted in red, indicating high sanitary risk scores and high thermotolerant coliform counts.

Figure 16 Flow chart showing system inventory and coliform presence

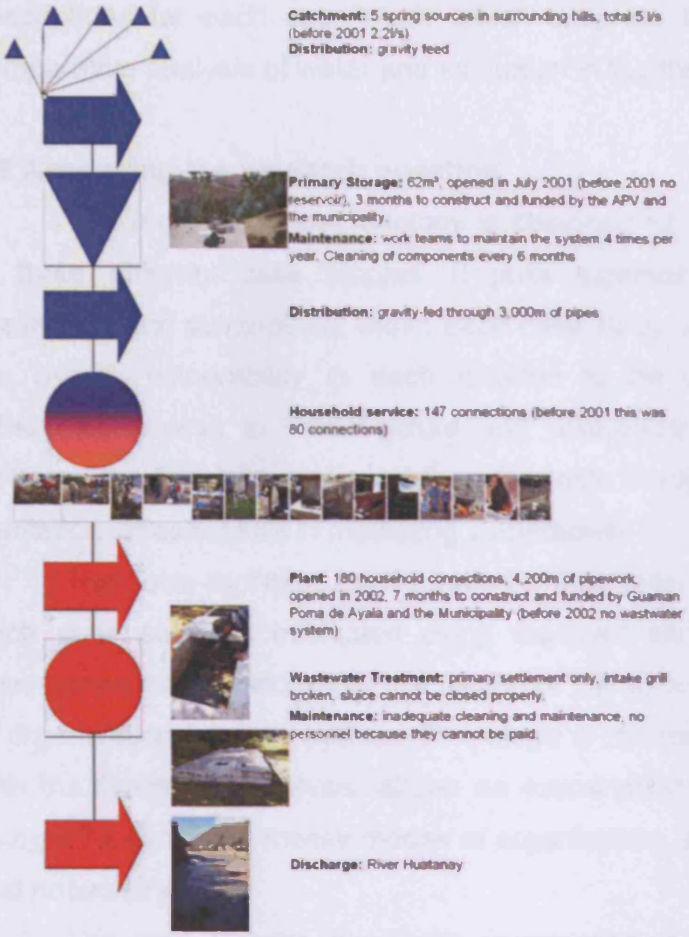


Table 16 Flow chart symbols

Symbol	Definition of Symbol
○	Operation: operations resulting in an intentional change in water
□	Inspection: examination or test
▽	Storage: water is stored
⇨	Transport: water is moved
◎	Combined activity

Adapted from Table 3.1 Process flow diagram symbols and WHO Water Safety Plan documentation (Davison et al. 2005;Davison & Deere 2006)

These socio-technical characteristics are pulled together in system descriptions for each case study which integrate the WHO indicators for a comparative analysis of water and sanitation in the three locations.

3.6 Answering the research question

This multi-stage methodology is designed for the analysis of livelihoods in three different case studies. It pulls together a picture of household livelihoods and vulnerability within each case study. At the same time, it allows the overall vulnerability in each location to be distinguished in terms of differential access to infrastructure and differential access to institutions of governance. The methodology is therefore able to explore the role of water and sanitation infrastructure in mediating vulnerability.

The socio-technical configuration of the water systems weaving through each case study is evaluated using standard water supply indicators; the governance framework; and a discussion of the socio-technical scale and mode of organisation for each system. This stage of the methodology, in combination with the livelihoods analysis, allows an examination of household vulnerability using STS concepts: messy modes of organisation, splintering, local resistance and networking.

The next chapter introduces governance in Peru and Cusco. This is followed by an in depth analysis of livelihoods in San Blas, Angostura and Manco Capac. Chapter 8 then relates vulnerability and differential access to infrastructure and institutions to the socio-technical mechanisms that drive splintering, local resistance and networking.

This then leads back to the research question in Chapter 9 and my concluding argument for the mediating role played by infrastructure and the socio-technical nature of this role.

Chapter 4 Peruvian governance shaping infrastructure and livelihoods in Cusco

This chapter introduces Peru and the three case studies in Cusco. Each case has been chosen to exemplify key aspects of the relationship between the vulnerability of urban livelihoods, governance and the mediating role of water and sanitation infrastructure. This is the first step in formulating an empirical response to the research question.

Each section presents the historical and political context using the state, market and civil society categories of the governance framework. It reflects the structure of Section 2.2 by looking at dilemmas over the role of the state and the impact of changing development theories on Peru in the nineteen-sixties and seventies. Attention then shifts to the neo-liberal, market oriented Peruvian policies of the early nineteen-eighties and the decade's debt crisis. With renewed global attention on the human impact of macroeconomic adjustment which followed the debt crisis, the civil society component of governance is re-examined with a focus on the rhetoric of participation and decentralisation as it has played out in Peru.

This is followed by a closer look at Peruvian water governance and the divergence, in Cusco, of idealised governance structures and day to day provision as discussed in Section 2.3.

In order to place each case study in context, I then apply the governance framework to urban Cusco. This gives an interesting picture that parallels the national Peruvian story and is useful for explaining some of the triggers for greater intervention of the state in the provision of housing and services in the fifties and sixties and the mixed results of highly centralised land reform and interference in urban politics.

I then argue that the activities of private and civic actors shaped and often compromised the development of urban services, as the private sector speculated, on one hand, while, on the other, rival urban and rural civil society groups vied for, and eventually cooperated to make, territorial claims. I describe the clashes between local civil society associations and central government and then the regional opposition to central government that gathered pace in the mid-eighties and launched local government as an important protagonist in Cusco's development.

Bringing the review up to the present, what we find in Cusco is a city shaped by the political turmoil of the seventies and the economic crisis of the eighties and early nineties, with three case studies experiencing very different

levels of vulnerability, access to water and sanitation and potential to influence governance.

4.1 State versus market: governance and economic shocks in Peru

Peru's fate since its independence from Spain in the 1820s has been tied to the vagaries of the global economy[48]; to an oscillating and tumultuous struggle between dictatorship and democracy; and tensions between centralisation and regional identity. It is useful to briefly track some of these dramatic swings since they frame both the governance of water and the activities of civil society.

By 1960, the population of Peru was almost 10 million and migration from the mountains to the cities was on the rise. It was a time of urban growth characterised by land invasions, self-help associations and collective action to demand basic infrastructure (Flindell Klaren 2000). Pressure was mounting on the state to industrialise and create employment.

In 1968, Peru's civilian government was overturned in a military coup led by the charismatic and impatient Juan Francisco Velasco Alvarado who swept to power promising land reform and economic independence[49] (Koonings & Kruijt 2007). As Velasco was trying to consolidate his position in the 1970s, however, Peru, like many countries in the region, was hit by a painful recession brought on by the oil crisis that was crippling the economies of the north[50]. Interest rates spiralled and Peru was persuaded to renegotiate its loans on condition that it adopt the International Monetary Fund's (IMF) austerity measures, including wage freezes and cuts in public spending.

---

[48] first, to feeding Europe's industrial revolution with the export of fertilizers and, then, to the fortunes of the USA with booms during World War II, the Korean War and Castro's revolution, and interim slumps which coincided with Europe's post-war recovery, periods of cotton dumping and the imposition of mineral tariffs by the US

[49] The influence of the Latin American structuralists – described in Section 2.2.1 – permeated President Velasco's rule with the regime instituting an agrarian reform programme, a massive expansion of the state, the nationalisation of mining, fishing and steel and the formation of pacts with the Soviet Union, Eastern Europe, Japan, Western Europe and China in an attempt to diversify away from a dependence on the United States (Koonings & Kruijt 2007).

[50] This led to drop in demand for exports and triggered a painful recession and increased borrowing from international lending bodies. The USA used this moment of weakness to force Velasco's government into settling a sixty year dispute over oil rights before credit would be released to Peru. Additional lending to service growing national debt ensure and, by 1976, Peruvian foreign debt was more than four times its 1970 level and twice what it had been in 1974, standing at more than $4bn. To finance interest on these debts, many governments in the region released bonds, which raised real rates of interest, and resorted to printing money, which pushed up inflation. Anyone with any capital in the domestic currency changed it into a safer foreign currency and sent it out of the region as fast as possible.

This crisis eventually forced President Velasco to step down amid allegations of corruption and a series of massive general strikes. The country then saw a return to civilian rule with former president, Fernando Belaúnde[51] Terry, returning from exile in the United States, accompanied, by a retinue of Chicago Boys, schooled in the latest neo-liberal economic ideas. Together they formed a government which championed neo-liberalism, dismantling and selling off state run institutions[52] and preparing the ground for even more potent neo-liberal interventions a decade later.

To add to this upheaval, in 1983 the fabled *El Niño* effect failed to materialise leading to flooding in the north of Peru and drought in the south. The price of basic staples soared and, compounded by the global recession, Peru's economy sank once more into depression[53]. Meanwhile, an anti-government guerrilla movement, known as Shining Path, was gaining power on the back of proceeds from the coca trade.

Like the rest of Peru, Cusco was suffering economically as Belaúnde came to power in 1980. New migrants were arriving in the city, either fleeing Shining Path's violent revolutionary campaign or gravitating towards better services and opportunities. They began to settle in peripheral areas where they also encountered the poorest city dwellers, displaced from Cusco's historic centre by the burgeoning tourism of the 1970s and its hunger for space to establish hotels, restaurants and travel agencies. These marginal areas were territorially and politically excluded by their lack of facilities, information and access to life in the city. By the mid-eighties only about 20% of houses had adequate access to public services, described by Pino Zambrano as pequeñas islas en medio de un mar de carencias: little islands in a sea of want (Pino Zambrano 2004). The situation for everybody else was pretty dire:

> Services like water, sewerage and electricity were very inadequate. Only 50% of the population had domestic connections, 15% had access to public standpipes and the rest of the population, especially in marginal urban areas,

[51] Velasco's predecessor, first elected as president in 1963

[52] Employment in government fell by 70%, Peruvian exports declined, imports rose

[53] The country's wealthiest converted their currency into dollars and moved it out of the region. Formal sector employment dropped, informal markets expanded and tax revenues continued to slump. Rural famine encouraged migration to cities where malnutrition dramatically increased and the farmers left behind turned to the more lucrative cultivation of coca for export and cocaine production. By the late eighties, half of world coca paste supply came from Peru and amounted to twice the value of Peru's copper exports.

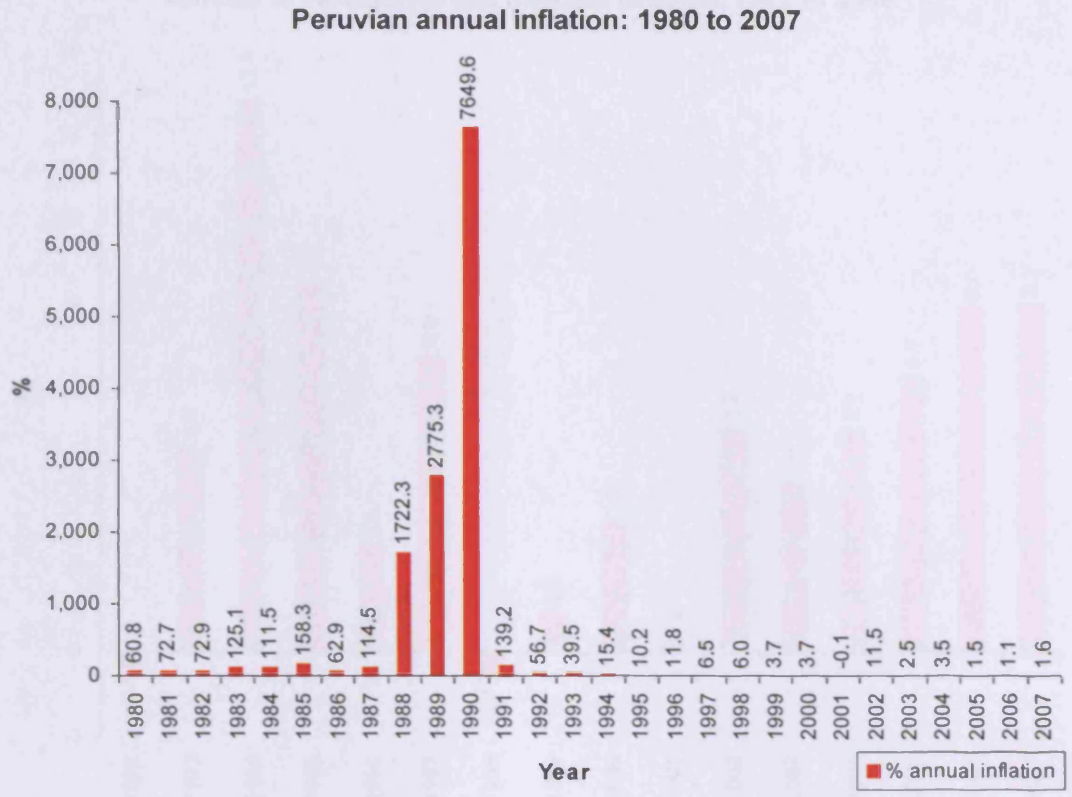
> went without this fundamental service. In terms of other services, 30% of people were connected to the sewer network, 60% had a domestic electricity connection and only 20% of families had a telephone service.
>
> (Pino Zambrano 2004):34

The next national election in 1985 saw a young Alan Garcia begin his first term as president. His response to the continuing debt crisis[54] failed to garner enough support and the IMF finally declared Peru's credit status "impaired". In 1987, Garcia made an abortive attempt to nationalise Peru's private banking system and in 1988 inflation soared to 7,000% bringing the government to the brink of collapse (Figure 5). Malnutrition, poverty and unemployment ensued. Then, in 1991, Cusco suffered an outbreak of Cholera for the first time since the nineteenth century. Two and a half thousand people died (Flindell Klaren 2000).

By this time, Alan Garcia had ceded control to incoming president, Alberto Fujimori. The messy power struggle which followed saw Fujimori stage an auto-coup and shut down the Peruvian Congress. Incredibly, this return to dictatorship reduced Peru's international credit risk rating since Congress could no longer oppose privatisation plans[55]. These plans went ahead and gave GDP a temporary boost in the run up to the 1995 general election. Fujimori, who had also managed to consolidate his control over social spending and strategic, vote-winning improvement programmes, was democratically re-elected (Flindell Klaren 2000).

[54] Principally, to limit loan repayments and lobby business to reinvest in Peru.
[55] In 1994 the state sold off its airports, telecommunications and airline industries to Spanish and Chinese companies

Figure 17 Peruvian inflation (National Institute for Statistics (INEI 2008a))



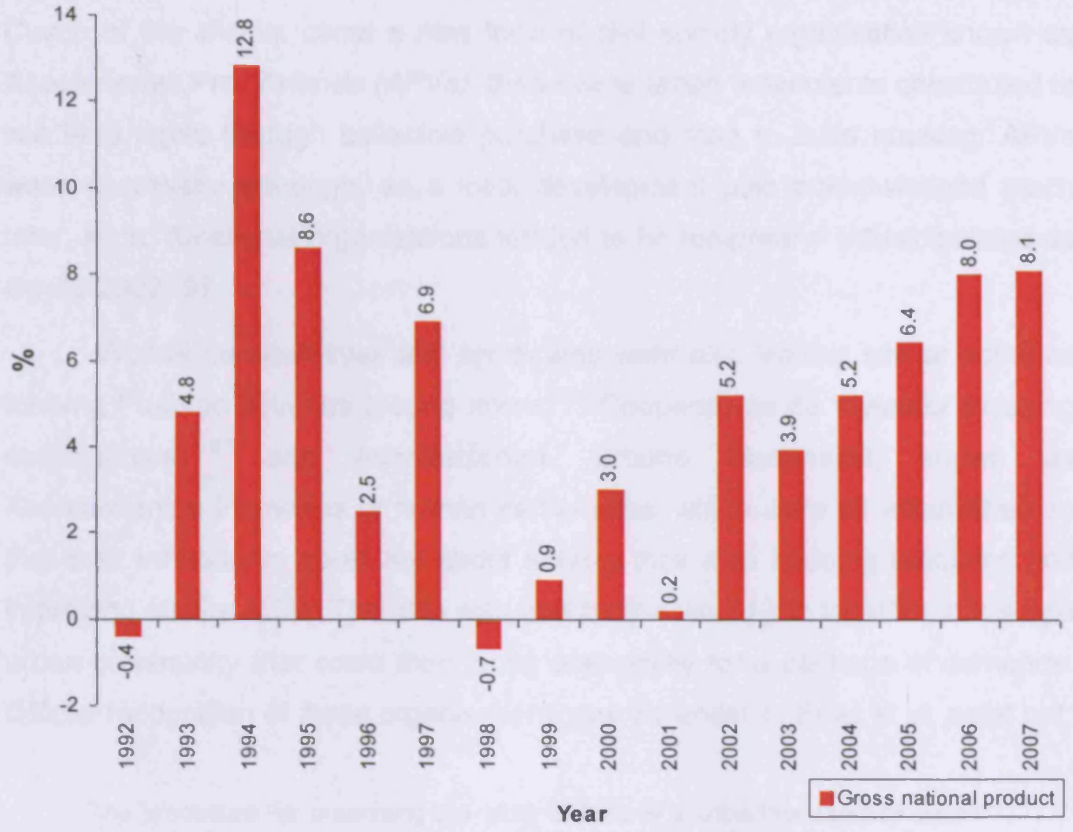
With the end of Fujimori's regime nearly 10 years later, the incoming president, Alejandro Toledo, brought with him a raft of legislation concerned with decentralization and the strengthening of local government.

In 2002, Peru held its first regional elections. As we will see in the following section, this brought about what is framed by the World Bank as an important change in emphasis. Client power, the direct participation of users in service provision, had apparently been nurtured to a point which could give way to a more sophisticated and profound participation in policy-making: the engagement of citizens and government in policy-level dialogue, or enhanced "voice" in the language of the World Bank (Reuben 2006):832.

In 2006, and in spite of his disastrous first term as president in the eighties, Alan Garcia won the presidential election. He is now presiding over one of the highest, continuous growth rates the since the 1950s at 8% in 2006 and projected at 7.5% for 2007-8, shown in Figure 6.

Figure 18 Variation in gross national product (National Institute of Statistics (INEI 2008b))

Annual % variation gross national product: 1992 to 2006



What is clear, however, is that the benefits of this growth are still not being felt symmetrically with the proportion of people living on $1 per day increasing from 44% to 46.5% between 2004 and 2006. There is also a distinct geographical split: Lima and the coastal regions play host to shiny, new shopping plazas while the remote highlands remain without even the most basic infrastructure (Weitzman 2007).

4.2 Peruvian Civil Society: NGOs and Decentralisation

Peru has an established tradition of development organisations. This is pertinent to the research question since these organisations have been particularly active in winning land rights and installing infrastructure services. The shifting sands of civil society in Cusco track the struggle for space and services that began in earnest after a massive earthquake in 1950 and continued unabated into the seventies as recession and agrarian reform began to accelerate rural migration to cities. As in many countries, however, the vocabulary of decentralization and participation in Peru has to be seen in the context of inequality and instability.

4.2.1 Civil and not-so-civil society

Out of what were often squalid and insecure living conditions in the Cusco of the sixties, came a new form of civil society organisation known as *Asociaciones Pro-Vivienda (APVs)*, these were urban movements constituted to win land rights through collective purchase and then to build housing. APVs were successful although, as a local development plan acknowledged much later, such "functional organisations tended to be temporary" (Municipalidad de Saylla 2002):97.

Worker co-operatives and syndicates were also leading similar activities forming Pueblos Jóvenes (young towns)[56], Cooperativas de Vivienda (housing cooperatives) [57] and Asentamientos Urbano Marginales, known as Asentamientos Humanos or human settlements, which were all established so that their inhabitants could set about solving their own housing problems and improving quality of life. The idea was that people would join together in a single urban community that could then lobby collectively for a package of demands. Official recognition of these organisations was essential as Frias et al. point out:

> The procedure for organising the plots of land is a collective exercise which takes place when circumstances or needs demand, so it is only once barrios and associations are properly recognised that they can get access to water, sewerage, electricity and other services, as well as the titles to the land.
>
> (Frias et el. 1992):59

Peru was still under civilian rule at this time and in 1966 a federation[58] was formed to bring all the APVs together. This federated model was based on a nationwide movement which had emerged from a Christian political tradition in Arequipa, another Peruvian city (Gomez Garcia 1989). The federation united nearly half of Cusco's disparate housing developments to lobby the region's deputies and senators for schools, services and waste collection and to support housing construction through a system of mutual aid.

The growth of these settlements in the late sixties and early seventies coincided with a new period of military rule under President Velasco. In response to this, the federation of APVs turned its efforts in the seventies

---

[56] Settlements based on land invasions within the city limits which used legal means to win land rights.

[57] Cooperatives set up so to buy land legally before occupying it.

[58] Known as the Federation of Social Urbanisation Circles- Cusco or in Spanish la Federacion de Circulos Sociales Urbanizaciones-Cusco

towards countering local land speculation and confronting SINAMOS, the pseudo-NGDO established as the 'human face' of Velasco's military regime.

SINAMOS was born out of President Velasco's drive to build a unified sense of nationhood and his concomitant reluctance to cede any power away from the centre. He formed this manipulative, pseudo-governmental bureaucracy to tap into potentially unruly urban movements and maintain the momentum of land reforms. This organisation – resonating with the dependency rhetoric of the time – was named the *Sistema Nacional de Movilización Social,* giving it the acronym SINAMOS, or *sin amos* meaning without masters. SINAMOS was mentioned several times during interviews so was influential enough to have left its mark on the popular consciousness thirty years on.

SINAMOS, ostensibly set up to implement urban policies and land reform, became a powerful tool in quelling civil unrest in Peruvian cities. The federation's resistance to SINAMOS was seen as "counter-revolutionary" and after a clash in 1973 the federation more or less disappeared. SINAMOS proceeded to create and dissolve various social organizations in an effort to get services into the poorest barrios. Frias et al. conclude in their 1992 analysis that SINAMOS was flawed in democratic and participatory terms but had at least acknowledged the importance of an integrated approach rather than localised or "parcelised" action (Frias et al. 1992):14. SINAMOS began the process of formally recognising urban settlements and although it was accused of offering technical assistance to communities for political ends, it was instrumental in awarding land rights:

> In 1971-72 ... SINAMOS legally recognized marginal urban settlements. The government of Velasco Alvarado recognized 80% of marginal urban settlements, and in the [first] period of Alan Garcia Perez's government, this process was completed so that currently 97.2% of the settlements hold the titles to their plots.
>
> (Ministerio de la Presidencia 1998):1

Part of the critique of the politically bland governance framework outlined in Section 2.2.3, was the assertion that: "not all civic groups are 'civil' in their behaviour" (Fowler 2000):6. This is exemplified in Peru under Velasco's regime, when a small group of civilian radicals based in a provincial university town managed to spawn Sendero Luminoso, otherwise known as the Shining Path guerrilla movement. By the following decade, eighty-five percent of Peru's Ayacucho Province, between Lima and Cusco, had been taken over by the

guerrillas. In 1982, the movement had become so violent and destabilising that incoming civilian president, Belaúnde, declared a state of emergency and placed Ayacucho under military control.

4.2.2 The long road to decentralisation

At the start of his first term in office in 1963, President Belaúnde, had held the first municipal elections for local authorities. This tentative decentralisation process came to a halt with the deposition of Belaúnde's civilian government in 1968 and what proved to be highly centralising tendencies of Velasco's incoming military government. It was thus not until the transition to democracy at the end of the seventies that a new constitution was drafted which split the country into twelve regions.

During Belaúnde's second presidential term and in spite of the violent unrest and inflation of the 1980s, Peru managed to hold its first municipal elections since Belaúnde's abortive attempts in the sixties. By 1988, however, only five of the twelve regional governments foreseen by the 1979 constitution were up and running. This process was set back again when, in the early 1990s Fujimori – a popular president without a regional party political infrastructure – staged his "auto-coup". He dissolved the nascent and obstreperous regional assemblies and installed Transitional Regional Administration Commissions which he nominated from the centre.

According to Michaela Hordijk, whose research on Participatory Budgeting in Peru identifies authoritarianism and populism as long-running characteristics of Peruvian political life, these changes were typical of the country's populist political tradition. She notes that ten years of Fujimori re-centralized power and resources to his Ministry of the Presidency.

> Regional governments had been abolished and replaced with appointed regional administration transitory commissions. The resource base of local governments (municipalities) had been cut through, curtailing some of the municipal rights to collect taxes; also, several important responsibilities that made local government visible to its citizens (such as providing land titles, and responsibility for social programmes) had been brought under the umbrella of the Ministry of the Presidency.
>
> (Hordijk 2005):222

The Ministry of the Presidency also controlled Fujimori's special social fund for rural projects, FONCODES[59]. Schady argues that between 1991 and 1995 this fund was used as a blatant electioneering tool, albeit one that had a slight redistributive function (Schady 2000).

This chimes with the tensions identified by Hordijk between populism (of the poorest) and authoritarianism (of the centre), simultaneously boosting the popularity of the central government, providing direct social assistance across a wide geographic area and circumventing any entrenched political interests in the regions. As we saw in the previous section, this led World Bank economists writing in 2006 to conclude that the channelling of social assistance in the Peruvian political environment of the 1990s actually took on a participatory flavour. These authors argue that in rolling out a proliferation of *vaso de leche* (glass of milk) committees – a scheme to provide nutrition to children – mother's clubs and other local associations, Fujimori's government encouraged the direct participation of beneficiaries in their own services.

In Peru, then, it has been possible for centralization and a popular brand of participation to coexist. Over the last fifty years the country has also seen strong municipal civil society, regional partisan activity, deep penetration of central government bureaucracy into urban life and violent regional rebellion. It was also possible for the apparent stability of centralized and dictatorial systems to be favoured by global governance structures: markets were able to invest safely in Peruvian infrastructure and the World Bank praised direct popular participation even though it subverted regional politics.

4.3 Peruvian water and sanitation infrastructure

It is to this backdrop that several important ideological and practical changes have played out in Peru's country's water and sanitation sector (illustrated graphically in Appendix A). This narrative is critical to the selection of case studies and gives crucial context to the socio-technical systems discourse as it will be applied to Cusco. It also demonstrates the overarching importance of governance in shaping urban services.

Before 1970, official responsibility for the development of water and sanitation was almost exclusively centralised in the Ministry for Public Works.

[59] Fondo Nacional de Compensación y Desarrollo Social: this fund is behind the Coredor Puno-Cuso Project local development initiative that is mentioned in Chapter 5 (Guasch 2006).

Under the military dictatorship of Velasco and in response to rapid urbanisation, responsibilities for water were split between the central ministries of housing (urban areas) and health (rural areas). According to the 1969 General Water Law passed by Velasco and consistent with his nationalistic rhetoric, water resources were considered the property of the state with licensed water companies obliged to supply the population before any commercial users (BID 1997):6.

This arrangement stayed in place until Belaúnde returned to power in 1980 and, though Belaúnde took steps to decentralise some administrative and operational functions, most technical and financial control remained centralised under a newly created National Water and Sanitation Service (SENAPA[60]). With the exception of three large urban centres, Lima, Arequipa and Trujillo, which retained independent control of water, SENAPA was structured into regional subsidiary companies and operational units[61] with tariff setting[62] and investment controlled by the centre[63]. By this time, the combined coverage of SENAPA and the three largest city systems amounted to 55% of Peru's urban population. A further 20% of the urban population was covered by parallel organisations controlled directly by provincial or district municipalities, while rural supplies remained in the hands of the Ministry of Health.

The structure of the sector did not change again until Belaúnde's successor, Alan Garcia, was coming to the end of his disastrous presidential term amidst the turmoil of horrific inflationary shocks. In the run up to the 1990 presidential election, Alan Garcia's party, APRA, despite his plummeting personal popularity, still had one of the oldest and best established political infrastructures on the ground, much more so than either of the potential presidential candidates, Mario Vargas Llosa and Alberto Fujimori. In a last ditch attempt to farm power out to his party's local representatives, Garcia passed legislation in early 1990[64] which stipulated that the companies and operational units of SENAPA be transferred to provincial municipalities in places where a

[60] Servicio Nacional de Agua Potable y Alcantarillado
[61] eleven regional subsidiary companies with administrative autonomy and fourteen operational units which remained dependent on direct management from the centre
[62] by the Regulatory Commission for Tariffs of Drinking Water and Sanitation (CORTAPA)
[63] SENAPA collected a 3% income levy from all the decentralised agencies.
[64] Ley de Organización y Funciones del Ministerio de Vivienda y el Decreto Legislativo 601

regional government had already been set up: a calculated and blatant political manipulation of the water sector (BID 1997):7.

In a surprise result Alberto Fujimori then won the 1990 presidential election and between 1990 and 1992 immediately went against his own pre-election rhetoric by instigating "Fujishock", a draconian and orthodox stabilisation package. The effect was to push up petrol prices by 3,000%, foodstuffs by 500%, electricity by 500% and water rates by 800%. As this was happening, his government continued the process of hurriedly handing over the SENAPA water companies to municipalities. This time decentralisation was calculated to pre-empt opposition to central government by forcing the responsibility for rapidly rising water tariffs onto the provinces where Fujimori had no real power base that could be damaged by such a move. In less than 6 months, 19 of the 25 companies and operational units had been transferred to municipalities with no proper period of transition and no co-ordination with other processes of decentralization (BID 1997):8.

The 1991 cholera outbreak saw Fujimori re-centralise control of SENAPA and prepare for legislation that would open the way for private sector participation in the Peruvian water sector. In 1994, he passed a new General Water Law . This allowed for water companies known as Entidades Prestadora de Servicios de Saneamiento, or EPS, to be constituted at a provincial level bringing provincial and district water systems under a single umbrella. This concessionary model stipulated that EPS companies could be publicly, privately or jointly owned[65]. In practice, the model overlaid a devolved Peruvian context which meant that district municipalities became EPS shareholders holding the right to grant the concession. On this municipal ownership model shares were apportioned according to the number of connections in each district.

In terms of regulation, water quality and environmental protection, seen as public health functions, were overseen by the Ministry of Health's Office for Environmental Health (DIGESA[66]). This body monitors drinking water quality, waste water and solid waste disposal and sets standards and indicators for the sector. It is the sector watchdog, SUNASS that regulates tariffs and the

[65] with total or partial exploitation rights
[66] Dirección General de Salud Ambiental

operations of all the regional EPS water supply companies[67] and rural water committees, Junta Administradora de Servicios de Saneamiento (JASS). An EPS has to include one provincial jurisdiction in order to be formally recognised and regulated by the sector watchdog (SUNASS) and is obliged to serve everyone within its boundaries whether they are defined as rural[68] or urban[69] (CEPIS 2000):2.

Notwithstanding the decentralisation of water and sanitation to provinces, the technology arm[70] of the Pan American Health Organisation (PAHO), found a patchy sector in 2000 without clearly defined institutional roles and with water systems performing badly because of high volumes of unaccounted for water, low coverage of water meters and lack of maintenance[71]:

> The lack of service continuity and the coverage of water disinfection are risk factors to health which principally affect urban and rural zones with the least resources.
>
> (CEPIS 2000):5

By 2000, of Peru's 30 rural and 164 urban provinces, only 94 came under the remit of one of the country's 45 official EPS. This left 70 provinces served by unregulated water companies with management by district municipalities, committees or some other informal community arrangement. These figures had shifted again by 2006, when the World Bank reported that 62% of Peru's population was served by 53 EPSs, 29% of the population by 11,800 formally constituted JASSs and the remaining 9% by 490 small municipal providers (Guasch 2006):329.

The picture of water provision on the ground was messy for two reasons. Firstly, some district level municipalities managed to hang on to their water companies rather than give them over to a provincial EPS. This suited both the district authorities, wanting to retain political control over services, and the nascent provincial EPS water companies, which were thus excused the

---

[67] Including the independent water company in Lima
[68] Less than 2000 inhabitants according to 1995 Water Law
[69] In theory, an EPS could be formed once it has 1,000 domestic connections across 6,000 inhabitants in a concentrated area.
[70] Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente
[71] Peru had been split into 26 regions each with a regional government. Peru had 1,832 municipalities, of which 194 were provincial – the level at which an EPS was to be constituted – and 1,638 were at district level.

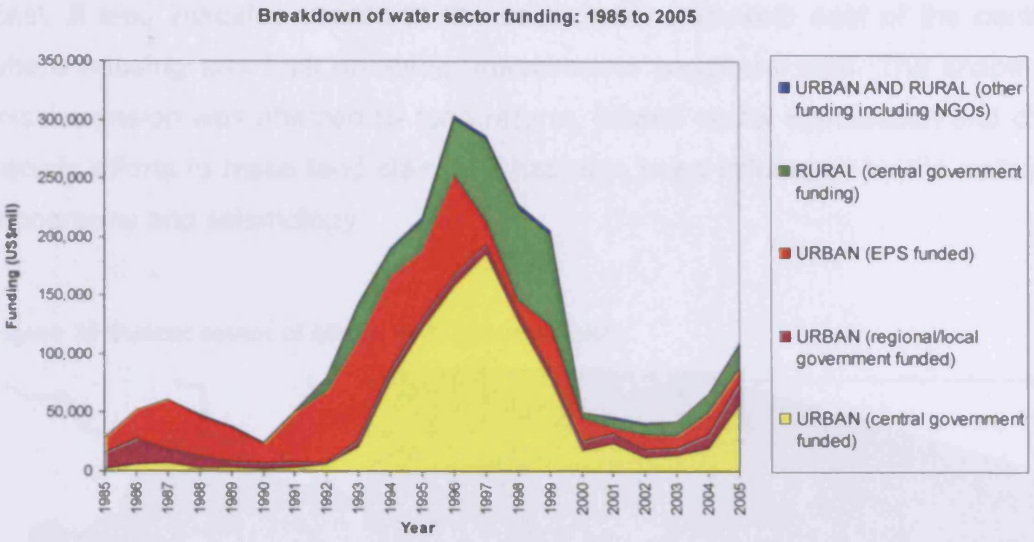
expensive responsibility of incorporating into their networks dilapidated systems built on challenging terrain. It also meant that these "parallel" systems remained completely unregulated. Secondly, the EPSs were intended to serve urban provinces *and* give technical support to more dispersed populations. Rural areas were frequently neglected under this model and provision remains a patchwork of water committees, some a legacy of nineteen-sixties regulation by the Ministry of Health or a hangover from FONCODES, the Peruvian Social Fund in the nineteen-nineties; some committees have been supported by NGOs and many have been formally registered as JASSs, or water committees (CEPIS 2000):2.

As per the provisions for private sector participation in water that had been set out by Fujimori in 1991, the first water concession granted to the private sector began operating in October 2005 serving Tumbes, a city of 94,000 in the far north of Peru. Several other schemes have been scheduled by the government's investment promotion unit and the Ministry of Housing, Construction and Sanitation, although municipal reluctance and poor systems for communication with the population remain important obstacles (Marmanillo 2006):176.

The original funding model for water and sanitation had the Ministry of the Presidency (PRES) as the governing institution able to channel funding into the sector via various special projects[72]. Figure 10 shows the breakdown of funding by source with central government funding and EPS investment in urban water supplies peaking between 1996 and 1998 when the last of the water authorities were passed over to decentralised, municipal control. This was also a peak time for rural investment from central government which had begun in the early 1990s. Urban water investment between 2000 and 2004 was split between regional and local government, the EPS companies and central government funding which began to pick up again in late 2004.

[72] Programa Nacional de Agua Potable y Alcantarillado (PRONAP) to support new water supply companies and Proyecto de Apoyo al Saneamiento Básico (PASSB) for basic sanitation

Figure 19 Breakdown of water sector funding (1985-1989 data from (BID 1997), 1990-2005 data from (Ministerio de Vivienda 2006))



So what we find in Peru as we launch into this research is a state that has only recently begun to devolve power to its regions and local governments. Its water sector, previously highly centralised and prone to political manipulation, has also experienced a very recent decentralisation process which is yet to incorporate and regulate the messy systems that fall between the institutional categories of provincial, regulated EPSs, rural JASS and self-regulated water committees. The distinction between urban, rural and actual jurisdictional boundaries is blurred and the teeth of the regulator and environmental and health monitoring are not as sharp as they might be.

The three case studies on which this research is based reflect these institutional arrangements. San Blas, in Cusco's historic centre, is served by SEDACusco the provincial EPS. Angostura, further down the valley, has its own independent water committee, or JASS. Manco Capac, which lies within the urban EPS jurisdiction, still relies on its own system built by the zone's inhabitants and managed by a local committee.

4.4 Governance shaping the city: state intervention, market speculation and civil society

The first photograph in Figure 13 was taken in 1963 and gives a rough idea of the city's limits and the cultivation which was still going on close to the

centre on the valley floor. The 1997 photograph in Figure 14 shows how the city rapidly swallowed up farmland in the valley as it expanded to the South and East. It also indicates growth to the south west and north east of the centre where housing was built on steep, inaccessible peripheral land. The shape of this expansion was affected by land reform, private sector speculation and civil society efforts to make land claims. It has also been influenced by the valley's topography and seismology.

Figure 20 Cusco: extent of city in 1963 (Source: ING)

Figure 21 Cusco: extent of city in 1997 (Source: ING)

On the 23rd May 1950, a massive earthquake hit the city of Cusco. Three thousand houses were destroyed and thirty or forty thousand people were left homeless. This disaster hit the city at a time when it was already bursting at the seams: it had seen significant growth since the beginning of the twentieth century with the boom of rubber and alpaca wool and the arrival of the railway. By the 1940s the city could boast an urban transport system (animal drawn), sealed roads, street lighting, a small-scale water service, limited telephony and a large central market. These changes were accompanied by a massive rise in the demand for housing and a quadrupling of the city's population from 20,000 in 1930 to 80,000 in 1950. In 1940, 78% of the city's inhabitants were renting, with the working classes living in old colonial houses or converted granaries and stables (Marco Cortez 1989). Rents were extortionate and sanitation practically non-existent. Overcrowding, sometimes with up to 30 families in a single house, forced the local government to begin a house building programme.

When the earthquake struck, at least fifteen thousand people were displaced to the east of the city centre and into temporary camps. Some were still living in informal settlements in and around the university stadium four years later. This event precipitated two trends of interest: the rise of community associations and more organised state intervention in housing and urban development.

4.4.1 State intervention

Faced with the pre-existing problems of urban expansion and the need to reconstruct after the earthquake, the state was forced to intervene and national and international organisations began to get involved in development. The city started to expand to the east and between the state (as the main developer of social housing) and to a lesser degree the private sector, the valley floor was developed as far as San Sebastian, shown to the South West of the city centre in Figure 16 above. This process tended to favour the middle and upper classes and was paralleled by unplanned and informal growth in lower income groups which complicated the issue of deeds and disrupted other aspects of urban planning particularly road networks. The city started to encroach onto agricultural land that was privately owned by the church and *hacendados* (feudal landlords).

Then came the military ruler Velasco's land reform programme in the late 1960s which forced the sale of rural, *hacienda* land around Cusco. At this time landless families made up about 25% of Peru's rural population (Flindell Klaren 2000) and large *hacienda* holdings were still run on a feudal basis by individual families.

4.4.2 Multiple civil societies: the blurred reality of private and civic

The hacienda land had been both home and livelihood to the *campesino*[73] communities who had occupied it. When landowners tried to evict *campesinos* after selling or leasing the land to urban workers with marginally higher cash incomes, conflicts erupted between the *campesinos* and the landowning hacendados. As more and more land was sold off these conflicts shifted focus and it was the *campesinos* and new urban settlers' APVs which found themselves at loggerheads (Marco Cortez 1989).

As the effects of the 1972 agrarian reform kicked in, *campesino* co-operatives gained strength and were able to claim rights to agricultural land that had been confiscated by powerful landowners or *hacendados*. The *campesino* groups then tended to follow the precedent that had been set by the big landowners in the 1960s and turned their land over to urban use without formal permission. One way for these groups to circumvent the legislation was to incorporate landless urban settlers and *campesinos* into a single association and make a claim together. On government owned land, the approach was less subtle and associations invaded and occupied land particularly on the banks of the River Huatanay. Key players within the community associations often became illegal developers themselves, selling land at extortionate prices with the promise of services and then delivering nothing: a reminder that urban community organisations are not necessarily coherent, unified actors.

4.4.3 Nascent local government

By 1984, after four years under the neoliberal national leader Belaúnde and with the guerrilla movement Shining Path spreading, inflation mounting and

[73] *Campesinos* are agricultural workers but the word has the same slightly ambiguous and derogatory connotations as "peasant" in English. Often these groups were landless, exploited tenant farmers.

devaluation imminent, Cusco responded by electing a new, leftist provincial mayor.

Daniel Estrada came to office at a time when local government in Peru was still in early adolescence and Pino Zambrano's retrospective of his tenure describes the poor public perception of the institution that he was to lead. Pino Zambrano's view is that municipal government at the time was seen purely as a forum for destructive confrontation between central government and local powers (Pino Zambrano 2004):34 and as an intimidating and incompetent service provider:

> To the population, the figure of the [provincial] Municipality was a symbol of abuse and arbitrariness, linked to life's three important moments: births, marriages and deaths.
>
> (Pino Zambrano 2004):33

Estrada's strategic approach was to encourage the municipal authorities to recognise and respect the citizenry, bolster the capacity of local government and local people and to improve basic services. In response to the economic crisis and the long queues for basic foodstuffs that it had precipitated, Cusco's municipalities participated actively in the "glass of milk" (*vaso de leche*) programme and collective kitchens (*comedores populares*). With international support, the municipality was also able to help barrios to launch *tambos comunales*: distribution points for stockpiling and selling essential products like sugar, milk, oil and flour.

Estrada also attempted to enhance participation, moving, as Pino Zambrano sees it, from reactionary popular activism to the "construction of citizenry" and a scrupulous effort to maintain the political independence of the municipalities:

> [construction of citizenry meant] the mobilisation of all sorts of local organisations ("living forces") which represented different forms of local, territorial, functional, professional and syndicate-based identities.
>
> (Pino Zambrano 2004):35

Behind the improvement of public services was one of Estrada's most spectacular contributions: an increase in municipal investment from $352,000 in 1982 to $9,000,000 by 1992. This was achieved by levying several local taxes. The first of these was to introduce a fee for groundwater abstracted by the

brewery. The second was the introduction of a tourist ticket which gave visitors access to important historical sites. Estrada had to coax local cultural and administrative institutions and the church into uncharacteristic cooperation by negotiating a mutually beneficial division of the ticket revenues. The third was an airport embarkation tax which also targeted tourists and diverted revenue from Peru's international airport in Lima to the regional hub of Cusco. Behind all this was a simultaneous change in national legislation which enabled small municipalities to borrow (Pino Zambrano 2004):13.

After three consecutive terms as mayor, Estrada's administration had facilitated the set up of a municipal company for waste collection and street cleaning and had negotiated an agreement with the regional electricity company for 90% electrification. In 1995, the stage was also set for a massive expansion of the drinking water infrastructure with SEDACusco, the provincial water company, in a position to finance a $35m project to tap into an important aquifer.

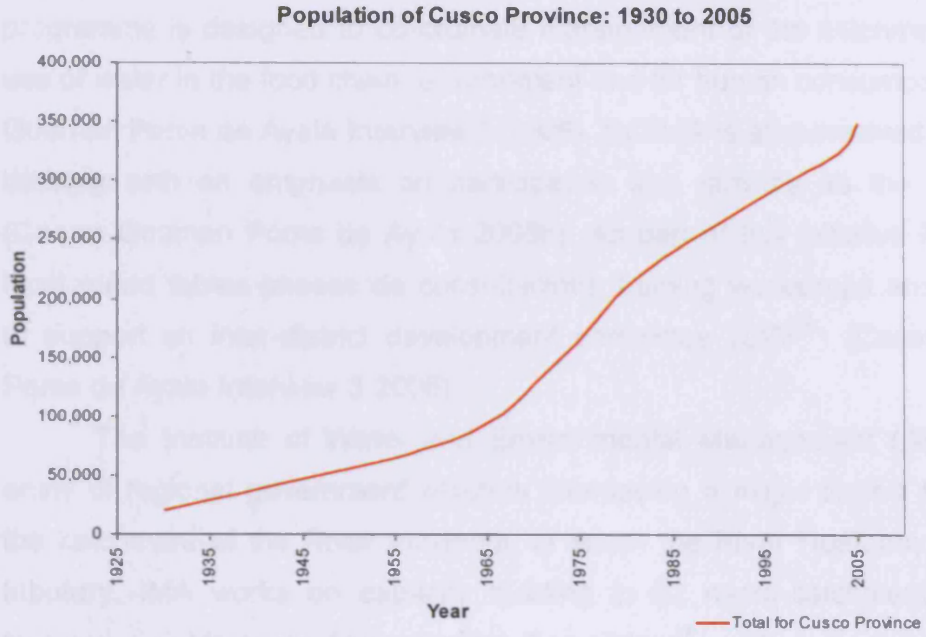
Following changes the legal framework for the provision of water and sanitation initiated by Fujimori's central government, by March 1997, SEDACusco had had its shares distributed among the district municipalities of Cusco and was granted the legal status of Municipal Company for Provision of Sanitation Services in Cusco, otherwise known as EPS[74] SEDACusco S.A. (SedaCusco 2008). Over the following decade, Cusco's economic growth and tourism crept up and efforts to increase investment and bolster the tax base, which had begun with Daniel Estrada, continued.

The growth of Cusco's population is plotted in

[74] Entidad Municipal Prestadora de Servicios de Saneamiento del Cusco

Figure 22 and tracks the city's expansion since through these periods.

Figure 22 Population growth in Cusco Province (1930 (Marco Cortez 1989); 1961 (Estrada 2002), 1972-1993 (Municipalidad Provincial del Cusco 2006), remaining data (INEI 2005))



4.4.4 Cusco now: governance and the environment

These days urban Cusco produces 10.4 million cubic metres of waste water per year or 330 litres per second of which only 30% is treated in the San Jeronimo treatment plant (Gomez Villasante 2003):19. The remaining 70% is discharged directly into the River Huatanay and this includes hospital waste, waste from the famous local brewery and untreated liquid waste from abattoirs. In terms of solid waste, the city produces between 240 and 310 metric tonnes of solid waste each day. Of the 70% that is collected by companies in each district, most is deposited in unlined landfill sites. The rest goes directly into the environment (SedaCusco 2005).

In response to this, over the last decade, several civil society and local government actors have launched development projects across the catchment area of the River Huatanay. Large scale environmental management has tended to fall to the regional authorities overlooking the different municipal jurisdictions that they straddle (Centro Guaman Poma de Ayala Interview 3 2006).

The Centro Guaman Poma de Ayala (CGPdA) is a local NGO that has played a prominent role in development of the Southern Valley and the Historic Centre of Cusco. It sees its role as that of facilitator bringing together the municipalities, the regional government, trade bodies, the churches and

community groups (Municipalidad de Saylla 2002). CGPdA has established Integrated Water Resource Management across the river basin (GIRH[75]). This programme is designed to co-ordinate management of the catchment with the use of water in the food chain, environment and for human consumption (Centro Guaman Poma de Ayala Interview 5 2006). CGPdA is also involved in capacity building with an emphasis on participation and families as the key actors (Centro Guaman Poma de Ayala 2006b). As part of this initiative it convenes local round tables (mesas de consultacion), training workshops and continues to support an inter-district development committee (CID[76]) (Centro Guaman Poma de Ayala Interview 3 2006).

The Institute of Water and Environmental Management (IMA[77]) is an entity of regional government which is overseeing a major project to clean up the catchment of the River Vilcanota, of which the River Huatanay is a major tributary. IMA works on capacity building in 22 micro-catchments and has founded the Vilcanota Management Committee[78], with a remarkably similar remit to CGPdA's integrated water management project (IMA Interview 1 2006).

SEDACusco sits on both the GIHR and the Vilcanota management committee but again the director of CGPdA commented that SEDACusco was difficult and had some influence over press reporting of environmental issues (Centro Guaman Poma de Ayala Interview 1 2006).

Regional environmental activities are underway and are linked in to local development projects but as we shall see the impact of these interventions is not always felt by or disseminated across Cusco's various districts.

4.5 Configuration of infrastructures

With the development of urban land outpacing investment in the provision of basic services for much of Cusco's history, a detailed 1992 study of Cusco's north-eastern sector, published by a local NGO, found a grim picture in areas where the land had been occupied by human settlements and APVs (Frias et al. 1992). The original invasions were usually characterised by the subdivision of the site into plots, their allocation was by community lottery followed by a phase of rough and ready construction. With only this basic level of planning, the NGO

[75] Gestion Integral de Hidricos Recursos
[76] Comite Interdistrital de Desarrollo
[77] Instituto de Manejo de Agua y Medio Ambiente
[78] Comite de Gestion de la Cuenca del Vilcanota

found that 80% of housing was poor to the point of being dangerous. It had been built on unstable land, predominantly by the communities themselves, and was without any basic services. In some cases, in the historic centre, a single tap or toilet would serve two households.

Frias et al. also took a closer look at Cusco's highly fragmented services and identified a number of reasons for the lack of integrated services. One explanation was that once a rudimentary system was in place, the impetus of the local social movement faded:

> Just as in other cities, community management is not an integrated activity, co-ordinated between different organisations. It is common to find diffused activities and scopes both within each neighbourhood and across the whole zone. Many projects to install urban settlements have been carried out by individual associations in their own particular way. The fact that they share common problems has not translated into different settlements coming together to make claims or undertake activities. As soon as the settlements have got hold of some basic urban services, they are no longer interested in a centralised organisation at zone level and this has led to the dis-activation of various housing organisations.
>
> (Frias et al. 1992):13

The authors conclude that there is an underlying sense of identity that is linked to a very local settlement rather than a larger area of the city.

> Only when there is a sense of identity at zone level is it possible to see participation in management and the transformation of the city as a whole.
>
> (Frias et al. 1992):14

Again, reflecting back to the DPU's examples of anarchic community organisation settling into formal structures, community organisations are not always durable actors in the provision of infrastructure.

Two comments from the research complete the picture:

> As one moves further away from the urban core, these settlements are more precarious, with the obvious deficit of basic services and located predominantly in ravines, on slopes and other places unsuitable for habitation.
>
> (Frias et al. 1992):43

> These contradictions in the city create spaces that are disconnected and segregated socially and physically with a consistent reduction in quality of life for the population.
>
> (Frias et al. 1992):45

What we find in Cusco is a city shaped by the political turmoil of the seventies and the economic crisis of the eighties and early nineties. Although its

tradition of social organisation and the strident, political leadership of Daniel Estrada in the eighties and nineties helped to build a foundation for participatory local development, underinvestment in basic services meant that by 1994, fundamental services in the city had practically collapsed – especially the provision of drinking water and drainage, street cleaning, electrification and transport (Pino Zambrano 2004):40.

In terms of water governance, arrangements across the city vary with SEDACusco, the EPS, covering a large part of the urban centre but with hybrid organisations covering splinters of the city and peri-urban zones. The rural JASS model for provision, operates in the southern valley and in the rural areas of each municipality.

4.6 The Lived Experience of Infrastructure in San Blas, Angostura and Manco Capac

This thesis is based on research in three case studies, in-depth interviews with householders[79], key informant interviews[80], household water sampling, river sampling and community workshops. The choice of case studies was designed to unpick the relationship between livelihoods and the governance and configuration of infrastructure. The sites are in different municipalities, with different governance models and configurations of water infrastructure, they all lie within the Province of Cusco and in the same basin of the River Huatanay.

The first case study, San Blas, is one of Cusco's oldest barrios and is served by the provincial water authority. Angostura, in a peri-urban municipality, runs its own water system, an untreated spring supply. Manco Capac, close to Cusco's main bus terminal and thriving markets, ought to be served by the provincial authority but is still using a system built and managed by the zone's inhabitants.

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[79] The focus of a livelihoods analysis is the household. While this method does recognise that vulnerability and assets may not be evenly distributed within a household and that strategies may be contested between people living under the same roof, the analysis effectively treats the household as a coherent unit. In the Peruvian census, household surveys distinguish between "lotes", "casas" and "hogares" CGPdA interview 6: un lote can have 2 patios, and several houses

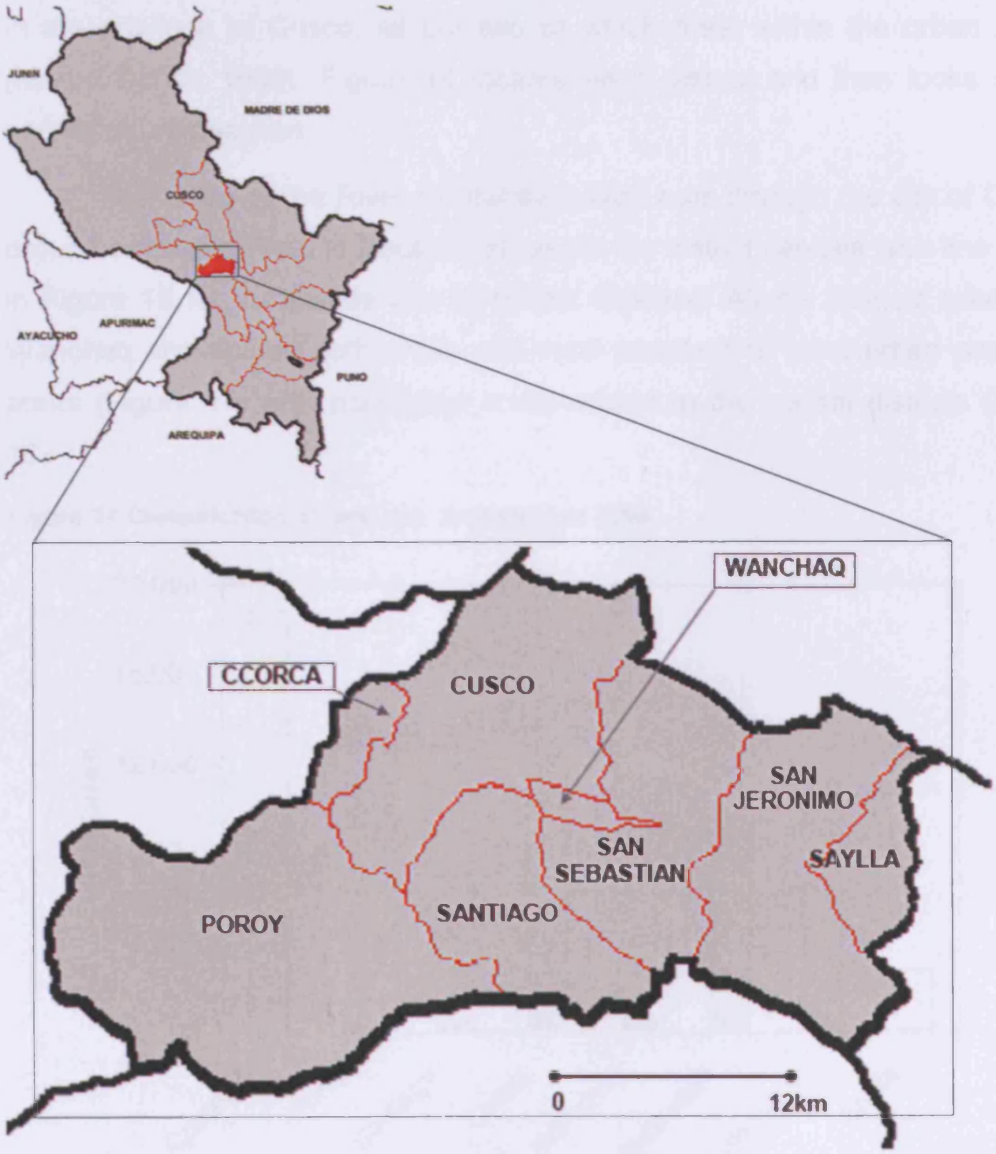
[80] Key informant interviews were modified to ensure questions were relevant to the particular interviewee. An open-ended dialogue was allowed to sit around the more formal, comparative structure of Strengths, Weakness, Opportunities and Threats. Interviews were recorded and transcribed.

The next section locates and reconnoitres each case study beginning with San Blas in the district of Cusco, Angostura in the district of Saylla and Manco Capac in district of Santiago.

Figure 23 Location of the Districts of Cusco

Department of Cusco **Province of Cusco**

1,171,503 people (INEI 2005) **348,493 (INEI 2005)**

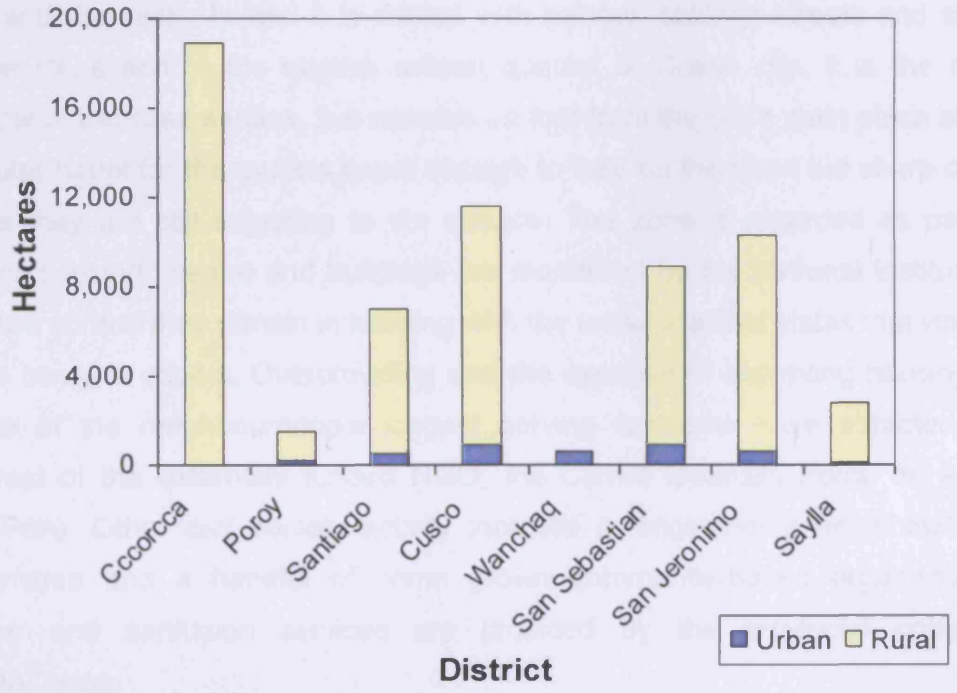


4.6.1 Locating the cases

Cusco Province originally comprised three districts based loosely on nineteenth century parish boundaries: Cusco, San Sebastian and San Jeronimo. In the early 40s, three more districts were formally recognised: Saylla and Ccorca in 1942 and Poroy in 1941. At the same time, house building for workers clustered around the city's new factories had begun in Wanchaq and Santiago which both became districts 1955. That brought to seven the number of districts in the province of Cusco, all but two of which meet within the urban scene (Marco Cortez 1989). Figure 16 locates each district and then looks at the spread of urbanisation.

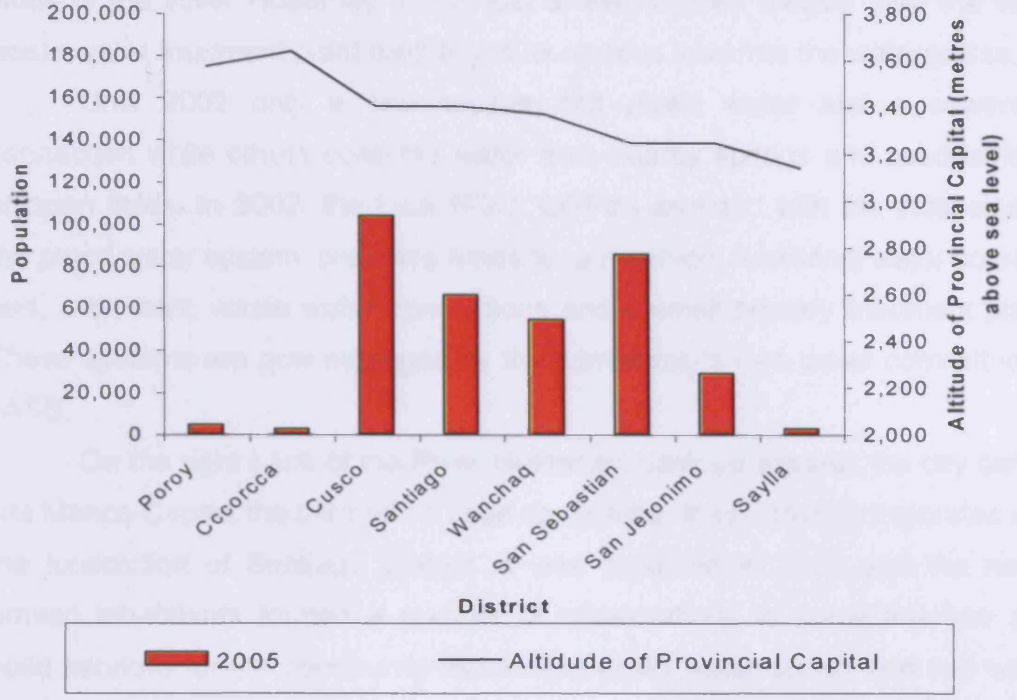
The valley of the River Huatanay, which runs through the city of Cusco, drops from North West to South East, as do the district capitals (see line graph in Figure 18 for an altitude plot of district capitals). All the districts except for Wanchaq still include both urban and rural populations[81] and urban and rural areas (Figure 17) with population concentrated in the central districts (Figure 18).

Figure 24 Classification of land use by district in 2004



[81] National Institute of Statistics' (INEI) definition of rural.

Figure 25 Population in each district of Cusco and the altitude of district capitals



The locations of each case study are shown below in Figure 19. San Blas, the first of the case studies, is perched on a steep hillside overlooking the city and the valley below. It is riddled with narrow, cobbled streets and steep stone steps and is the original artisan quarter of Cusco city. It is the most central of the case studies, five minutes on foot from the city's main plaza and a popular haunt for the tourists brave enough to take on the short but sharp climb while they are still adjusting to the altitude. The zone is regarded as part of Cusco's historic centre and buildings are monitored by the National Institute of Culture so that they remain in keeping with the terracotta tiled vistas that visitors have come to expect. Overcrowding and the expense of improving housing for some of the neighbourhood's longest serving residents have attracted the interest of the externally funded NGO, the Centro Guaman Poma de Ayala (CGPdA). Other civil society activity includes a longstanding neighbourhood committee and a handful of home grown community-based organisations. Water and sanitation services are provided by the provincial company SEDACusco.

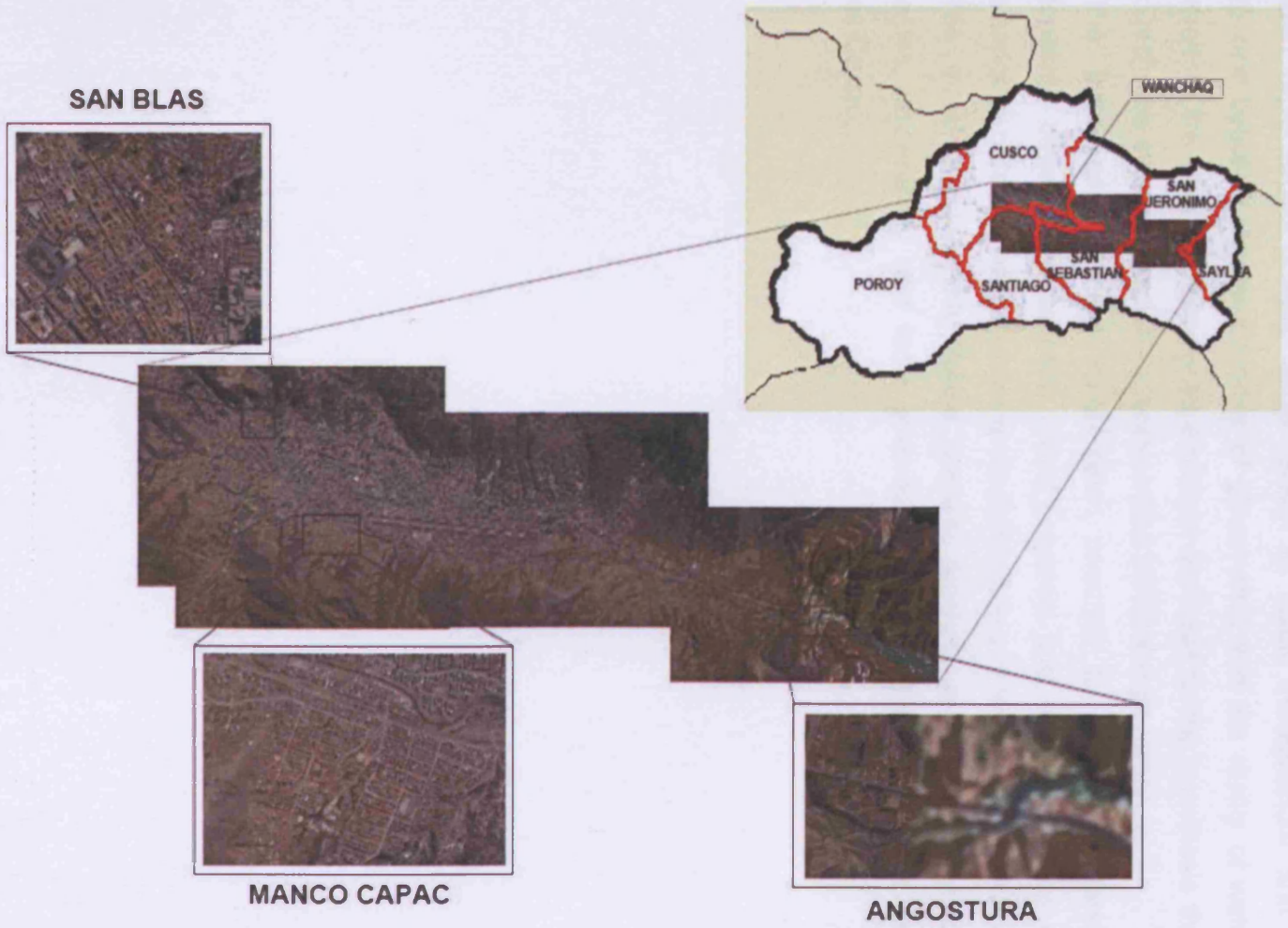
Further away from the centre of town is the settlement of Angostura in the outlying district of Saylla. A handful of residents formed an association to acquire the land in the early 1980s and since then it has grown into a

community of 147 families. It sits on the valley floor, with dwellings on both sides of the River Huatanay and is just a few hundred metres after the city's waste water treatment plant discharges its noxious load into the watercourse.

Until 2002 only a few houses had piped water and a sewerage connection while others collected water from nearby springs and used latrines or open fields. In 2002, the local NGO, CGPdA assisted with the extension of the piped water system, providing funds for a reservoir, additional water sources and, a bit later, waste water connections and a small primary treatment plant. These systems are now managed by the community's own water committee or JASS.

On the right bank of the River Huatanay, back up towards the city centre sits Manco Capac, the third of the case study sites, these days incorporated into the jurisdiction of Santiago District. It was occupied in 1965 and the newly arrived inhabitants formed a number of organisations to come together and build services for the community including a piped water supply and foul water drainage which was built at weekends and on public holidays over a five year period between 1985 and 1990. This water system is now administered by a community-based organisation called ASAPASC. Other environmental services are the responsibility of the municipality but this cash-strapped district authority is unreliable and unpopular. The international NGO World Vision is active in the area running a child sponsorship programme and health workshops and two other local organisations run a small primary school and a nursery.

Figure 26 Case study locations in Cusco Province



This chapter takes the first steps in an empirical response to the research question. The governance framework is applied methodically to the context of national, local and infrastructure governance in Peru.

I argue not only that Peru's volatile political and economic history has been pivotal in shaping infrastructure provision but that controversy over infrastructure has also driven political change. This gives a first insight into the links between remote but powerful government policy, the practical organisation of infrastructure and urban vulnerability.

With rapid urban growth, social action to install infrastructure and a divergence between idealised modes of governance and the reality of water provision on the ground, Cusco is an excellent test case for my hypothesis that socio-technical systems mediate between vulnerability and governance.

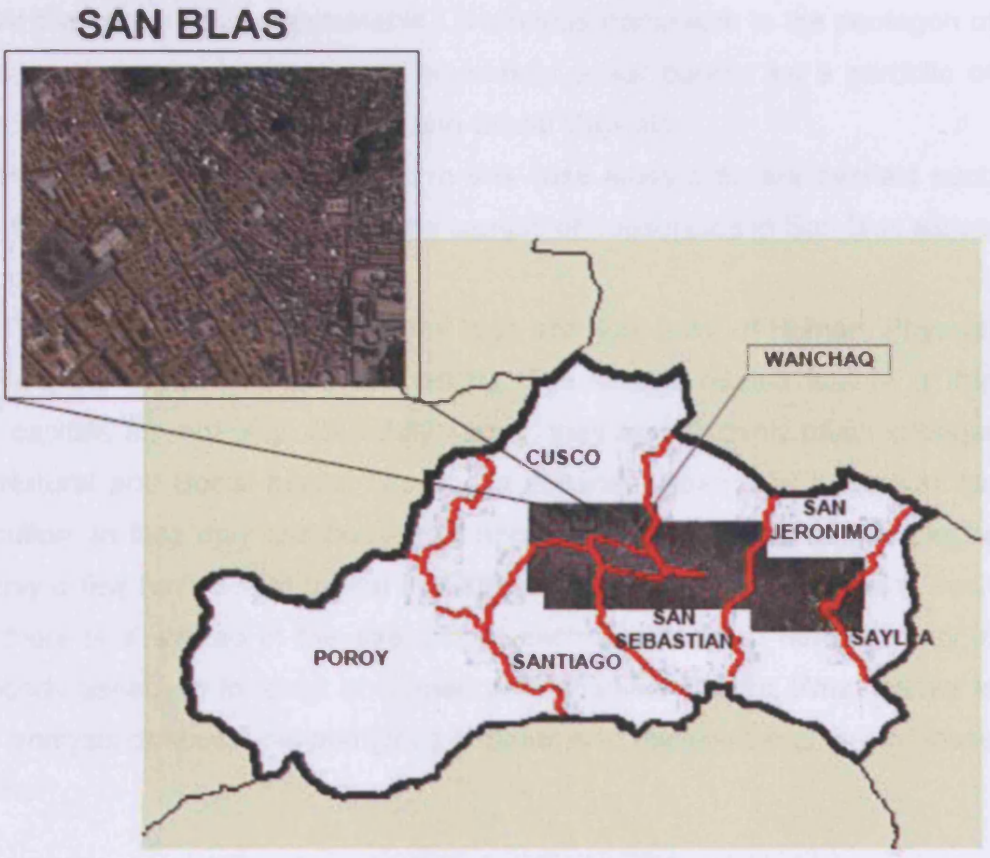
The three case studies have been selected to illustrate different relationships between households, water providers and wider structures of governance in order to characterise the mediating role and interaction of STS.

The three chapters that follow present detailed studies of livelihood strategies, vulnerability and local governance in San Blas, Angostura and Manco Capac.

Chapter 5 San Blas: 'agua matinal'

This chapter examines the livelihoods of households in the San Blas neighbourhood of Cusco District. The chapter is structured according to the four analytical categories offered by the Sustainable Livelihoods framework. The first of these focuses on livelihoods, gathering households into three thematic groups characterised by similar asset bundles and livelihood strategies and based on the results of household interviews and sanitary surveys. In San Blas, the groups have been given the following titles: 'establishment', 'entrepreneurial' and 'excluded' livelihoods.

Figure 27 Location of San Blas



The second analytical category, Vulnerability Context, situates the neighbourhood in its municipality, describing aggregate economic life, demographics and risks, shocks and stresses faced by households.

The third section presents a discussion of policies, institutions and processes under the heading paths to influence. This describes the roles of neighbourhood and civil society organisations, the municipality, central government and the private sector.

San Blas is the oldest barrio of Cusco city, built on a steep outcrop of rock on the northern slopes of the town (Figure 25). It was created as a parish between 1559 and 1562 (Municipalidad del Cusco & Instituto Nacional de Cultura 2006):14 to house indigenous Inca families that had been forced out of the new colonial city by the Spanish. San Blas overlaid an older Inca barrio called Tococachi, translated by its modern day inhabitants as "Salty Hollow" (San Blas Community Meeting 2007).

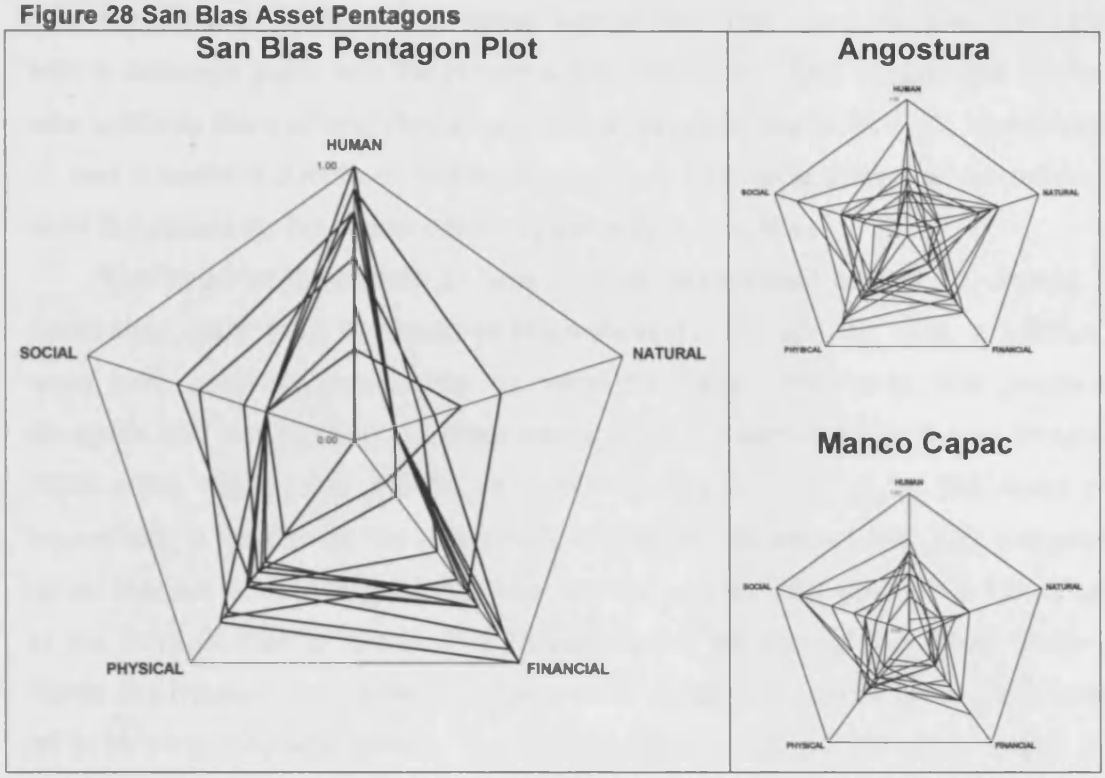
5.1 San Blas Pentagon Plots

At the centre of the Sustainable Livelihoods framework is the pentagon of assets, designed to represent the household asset bundle as a portfolio of Human, Natural, Financial, Physical and Social Capitals.

Pentagons for each household in this case study area are overlaid such that a first glance over the plots for the sample of households in San Blas allows some preliminary comments.

The first feature of interest is the high absolute level of Human, Physical and Financial capital in this urban setting. The second related feature is that these capitals are not only absolutely strong, they are relatively much stronger than Natural and Social capital, yielding a dominant, triangular pattern in the distribution. In fact, only one household appears to have strong natural capital and only a few have social capital that stands out. Finally, looking along each axis, there is a spread in the strength of each asset class: heterogeneity in livelihoods especially in terms of Human and Financial Capital. What follows is richer analysis of household and group interviews to explore the origins of these patterns.

Figure 28 San Blas Asset Pentagons



5.1.1 *Establishment Livelihoods:* education and stable employment

In this section, Households 17, 22, 24 and 27 have been grouped under the heading Establishment Livelihoods, characterized by high levels of education and stable employment. One of the features that emerged during the interviews in San Blas was the apparent ability of these households to capitalise on their education and training. This meant a smoother and more predictable monthly income, often from formal sector, professional employment.

This was true for Household 17 with the head of household, working as an accountant, his wife based in the home and his eldest daughter, employed as a teacher with her siblings still at school or university. The father's monthly income was described as "stable" at 800 soles (£137) per month while the daughter had short-term contracts and was paid around 500 soles (£86) per month. For this situation to arise, university level education was necessary across both generations. Household 17 was an owner occupier and even with 14 years in their current house and 26 years in San Blas, this family had arrived more recently than some others. Certainly, in terms of physical assets, this professional household was at the top end. Home ownership served to stabilise monthly outgoings since there was no rent to be paid and the house

construction was reinforced concrete with a tiled roof, the patio was concrete with a drainage point and the principal tap, although it was outside the house, was built into the wall and discharged into a concrete basin. All in all, Household 17 had a resilient bundle of human, financial and physical assets which reflects what is happening in several other households in San Blas.

The head of household 27 was also an accountant but, at 70, almost a generation older than the head of Household 17. He and his wife, a teacher, were both university graduates, as were the other inhabitants: the couple's daughter and her husband, a shop owner. The household income was around 3000 soles (£515) per month, with half of this brought in by the head of household, a quarter by his wife and a quarter by his son-in-law. This included rental income from letting out two commercial spaces that gave onto the street at the front of their property. The house was of adobe but the wood flooring inside the house and drained, concrete patio outside, placed it among the best off in terms of physical assets. The demographic in this household changed as family members came and went during the year but at the time of the interview, apart from a very new baby, the only other child was the "*trabajadora del hogar*": a 14 year old, live-in domestic help.

In Household **22**, the female head of household was also a teacher on a salary of about 900 soles (£155) per month. She was a relative newcomer and had only lived in San Blas for 8 years. In some ways, she fits between the establishment and the enterprising livelihood groups because she supplemented her income by letting rooms to two local artisans and was not a long-time resident but her income security has persuaded me to place her here. Again the house was adobe construction but inside the flooring and installations were at the top end and although the patio was unsealed, it was drained.

Household **24** was exceptional in the San Blas sample in that the retired teachers who lived there had been renting the same state-owned house for 34 years, since their marriage. They paid a nominal rent, which hardly dented their teachers' pensions, and occupied themselves in retirement with their own small NGO and the husband's work as an artist. Their grown-up daughters, lived abroad with European spouses and this links to the story behind their NGO. This couple had made a deal with a capricious, local nun, the owner of a decrepit colonial house. They restored the house and then rented out rooms to local students, artisans or tourists and set aside a small room for their own

domestic helper. The project seemed to be under constant threat of eviction, at the whim of the nun, but its rental income was designed to fund the main activity in the remaining rooms: a workshop for young, deaf seamstresses, making clothes to order for export to Austria, where Household **24** had offspring. The workshop specialised in costumes and sports strips and the head of household admitted that:

> I sometimes earn a little from my project and I also have a little business in the centre, a café. But the income from the tenants goes back into the project. The difficult months are November, October and December because, for example, we have sent clothes to Europe for Christmas and we still haven't received the payment. HH22

This enterprising activity might have shifted Household 24 out of the established livelihoods and in with the entrepreneurial but I have kept it here because it had such a stable main income source and the extra-mural activity had more than a profit motive attached to it.

To pull together the picture of assets and make the first links between livelihoods and water: Table 16 and Figure 27 present household assets linked to water.

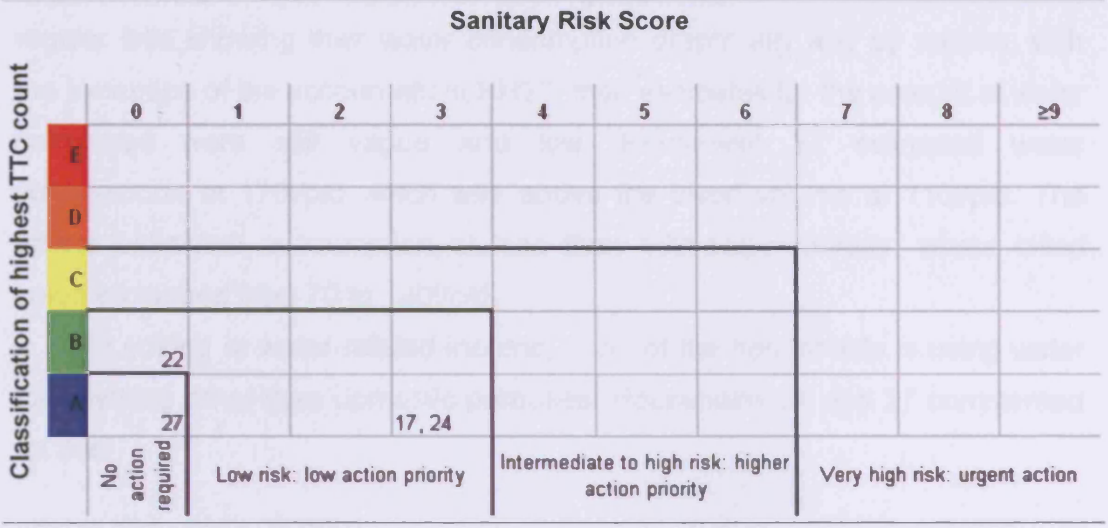
The combination of low sanitary risk scores and the absence of thermotolerant coliforms indicated low overall risk in these households[82].

Table 17 Households and Taps in Establishment Group, San Blas

Household 17 'accountant and family'	Household 22 'teacher and lodgers' 3 people	Household 24 'upstanding, retired teachers' 2 people	Household 27 'old-timer accountant' 6 people
5 people, 2 taps	3 people, 1 tap	2 people, 2 taps	6 people, 6 taps
			

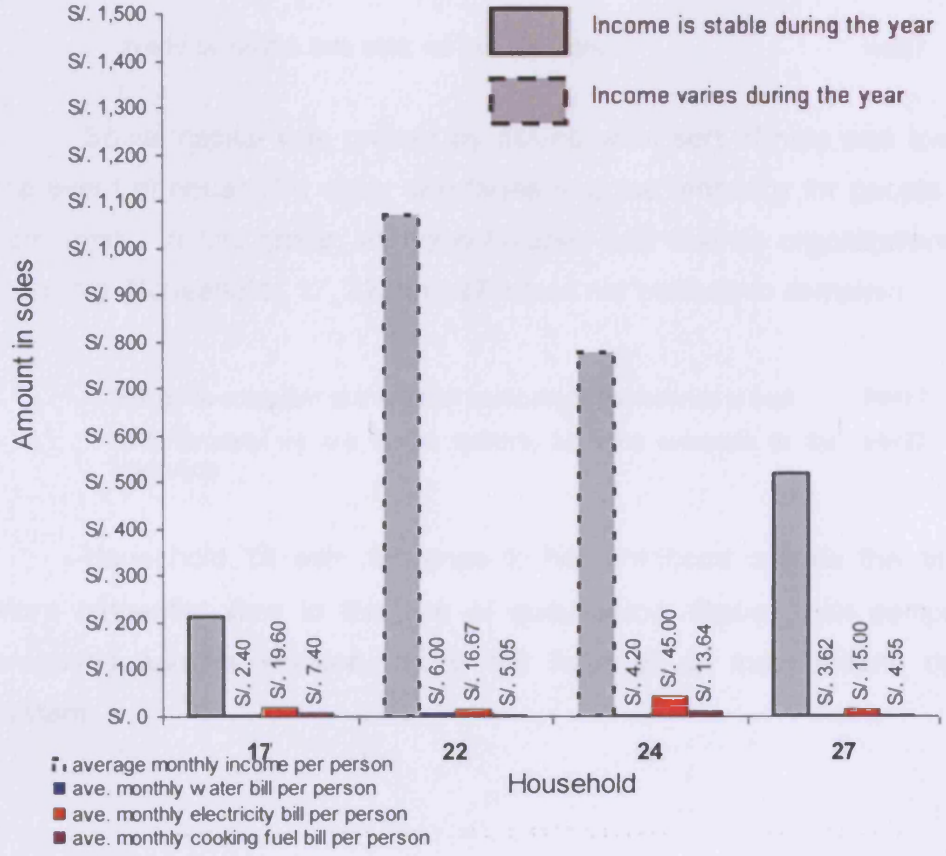
[82] Household 22 had a faulty tap which sprayed out horizontally and was contained using a wrap of clear plastic. Samples were taken with and without this improvised hose and results showed the presence of TTCs in samples taken with the hose.

Figure 29 Sanitary risk score in Establishment Group, San Blas



Incomes in this group were stable but slightly lower in Households **17** and **22** and more variable but higher on average in **22** and **24**. Gas was the cooking fuel of choice and expenditure on energy and water was higher than in the other case study sites and than in the Excluded Livelihood group in San Blas.

Figure 30 Monthly income levels and utility expenditure per person in Establishment Group, San Blas



Although all the households in this group had water meters and received regular bills showing their water consumption graphically and by volume, with the exception of the accountant in HH27, their estimates for the amount of water consumed were still vague and low. Household 27 estimated water consumption at 170l/p/d which was above the billed volume at 110l/p/d. The others estimated consumption at less than 15litres/person/day, where billed volumes ranged from 70 to 140l/p/d.

Looking at water-related income, none of the households is using water for anything other than domestic purposes. Households 24 and 27 commented on this:

We water the plants and once a month hose down the patio	HH24
Domestic use only, we water the plants but they're not for sale	HH27

Human capital is examined in terms of the attempts of households to treat drinking water and any reported links to health. All households in this group boil drinking water before consuming it and none reported what they saw as water-related illnesses in their families:

Just to be on the safe side, we boil the water	HH27

Social capital was probed by asking what sort of help was available in the event of household water shortages and the tendency for people to lodge complaints. In this group, all householders said that no organizations helped them out. Households **17, 22,** and **27** would not hesitate to complain:

We go to complain at the water company if the service is bad	HH17
Unfortunately we are in the system, so we'd complain to the institution	HH27

Household **24** with reference to her childhood outside the city took a more tangential view to this line of questioning. Rather than complain, she proposed another solution, along the lines of an independent, communal system:

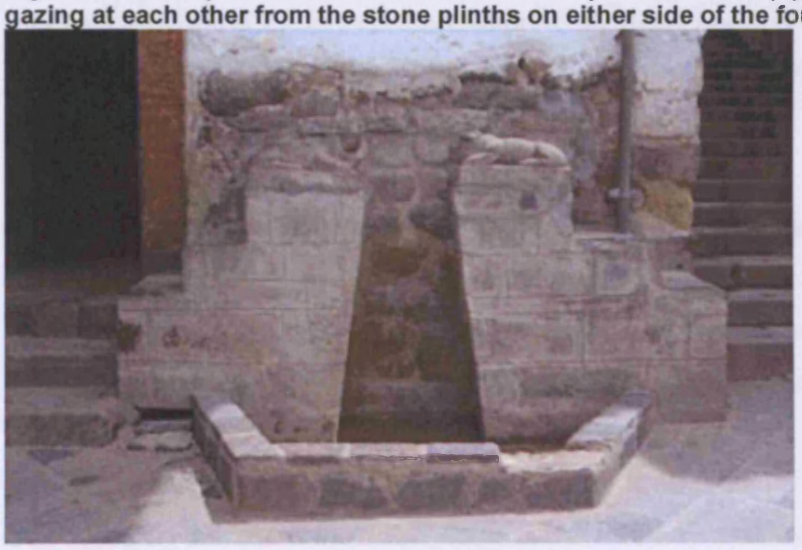
> [if there was a problem,] first I'd buy bottled water but there is water in the subsoil, we would have to get together to do something. I know how to filter water. When I was a child, my father mate a "canasta" (literally translates as a "basket" but more like a tub or barrel judging by her description) with gravel on the bottom and sand and coal on top and my father is 82! HH27

Only HH**24** and HH**27** reported using alternative sources of water. I use this information as a proxy for a natural capital linked to water.

> I have to buy bottled water HH24
>
> We send the domestic to "el perro" or, in the past, to the "los sapos". There's also the beer company's exclusive source, there's a tank HH27

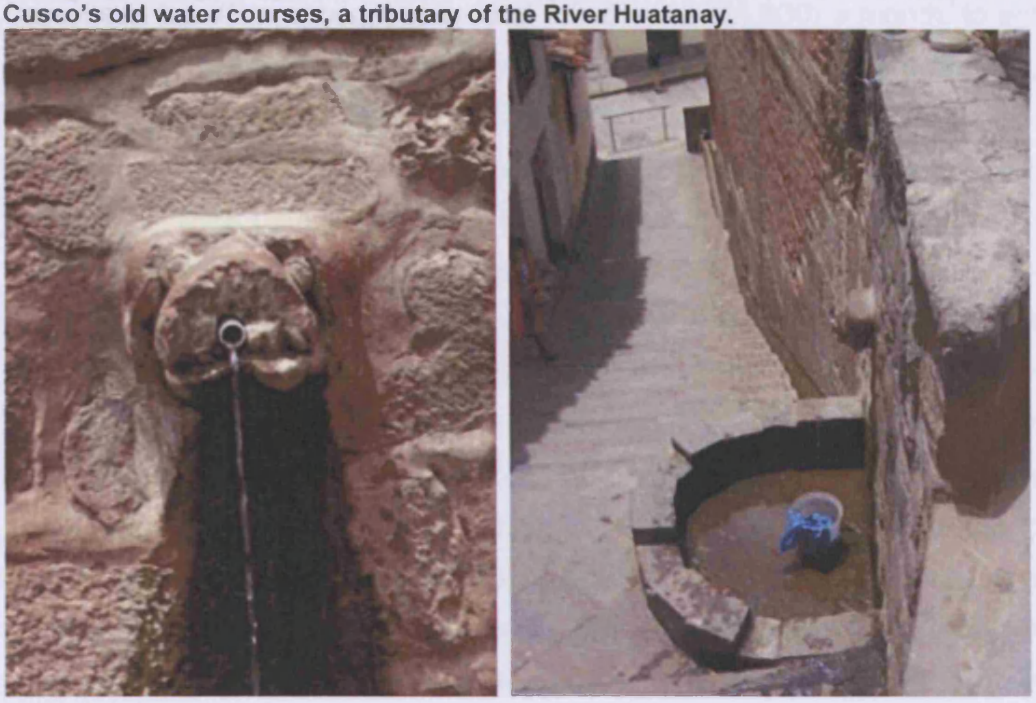
A couple of households (HH**27** in this group and HH**29** in the final group) referred to "el perro", the dog, and "los sapos", the toads. It turned out that these were public fountains. *"Los sapos"* is dry but *"el perro"* still runs continuously into a stone channel next to a flight of steps. The households that referred to "el perro" were both local and level with it[83].

Figure 31 "*los sapos*": means "the toads" and if you look closely you will see them gazing at each other from the stone plinths on either side of the fountain.



[83] The provenance of the water was not clear but it was sampled for completeness and had no residual chlorine, incredibly high hardness values and showed the presence of thermotolerant coliforms. I saw it being used to fill buckets most days and I regularly saw one particular choclo vendor (a street seller who hawks boiled corn on the cob) filling her cooking pots for preparing her wares.

Figure 32 "el perro": at a stretch you can make out a dog's face in the left image and, on the right, drainage drops in a channel to Choquechaka below – this street follows one of Cusco's old water courses, a tributary of the River Huatanay.



Some of the factors behind the stability of these livelihoods seem to be having at least one generation's worth of higher education (human capital), home-ownership or low rent to stabilise outgoings and access to urban labour markets, including a high concentration of schools and the demand for financial services. In the case of Household 24, there was the potential for remittances and access to markets outside Peru.

5.1.2 *Entrepreneurial Livelihoods:* tourism and diversification

In this section, Households **18**, **19**, **23**, **26**, **28** and **30** are characterized as entrepreneurial. People here still have high levels of education, though not exclusively university degrees. What makes their livelihoods potentially more unpredictable is that they rely, in part, on businesses related to seasonal tourism such as letting rooms or handicrafts. It is more difficult to generalize in this category because the livelihoods are diverse and so each household merits some attention.

Household **28** houses the president of the neighbourhood committee: born and bred in San Blas. Although he is a trained lawyer and his wife a nurse, their main livelihood activity is making jewellery for export in a small home-based workshop. The income from this trade was described by the head of

household as "*de acuerdo al mercado*" or dependent on the market but it must have been lucrative enough, at around 6,000 soles (£1,030) a month, to entice him and his wife away from more predictable incomes in the professions for which they had trained. Their wares were for export which partly explains the profit margin. Their physical assets were correspondingly impressive with a multi-storey, brick house, wooden floors and the principal tap inside the house.

Households **18** had seven members with a completed tertiary but non-university education and three more in the process of completing their studies. The two home owners were brothers, living with their spouses and children. With this "adult" demographic, the household was able to have six family members working as teachers and one as an engineer, bringing in a steady 1600 soles (£275) per month. This has obvious overlaps with the first livelihoods category of stable and high level education in San Blas but what I want to highlight in this case is their supplementary income which came from running an internet café from their property. The house nestled next to a steep pedestrianised street, between a number of tourist hostels. This was a typical tiled, adobe house with a drained flagstone patio but the indoor floors were still earth.

Neither the head of household **19,** nor his spouse had completed their university education. He classified his work as "professional", but emphasized that it was "*eventual*" or casual and that his monthly income of 800 soles (£137) was what was coming in "at the moment". His wife also had a variable income that peaked during the tourist season at about 20 soles (£3.40) per day selling goods in the market. This couple had two school age children and they said that their income went down with tourist numbers in January and February and when the children went back to school in April because of the cost of buying uniforms and books. The other family member was the elderly mother. At 76 this woman was the oldest participant and she described her education as *"sin nivel"* or without any formal schooling. This household generated supplementary income from renting rooms in their colonial era house to a middle-aged couple (both described as artisans) and a younger university student. The rental income amounted to 70 soles (£12) per month from both the couple and from the student.

Household **30** was headed by another university educated woman. She moved to San Blas in 2002 and began building her house on what had been a

steep and slightly precarious vacant lot. Each time I visited her, the living space had expanded and she used these new spaces to supplement her income by letting rooms to local and international tenants. The foreign tenants paid in dollars and contributed between USD300-500 per month. She estimated her net income, after deducting the expensive electricity bill, at about 1000 soles (£170) per month. She lived with one school age child and her older, graduate son who worked as a tour guide bringing in about 600 soles (£103) per month.

In Household **23**, one source of income was from the head of household who earned around 1000 soles (£170) a month as a farmer and market stallholder. What marks this family out was that they owned land in the neighbouring province, Urubamba. This agricultural income varied and the head of household explained that it went up during the harvest period but that, the rest of the time between January and April he was "*pateando latas*", this translates roughly as "stoney broke". With this fluctuating agricultural income, the household strategy was to use supplementary income from the head of household's grown up children. Of these, one owned a shop and two other professionals were involved in tourism and industry They all had university degrees and brought in about 500 soles (£86) per month. The fourth sibling was still at university and the other junior members of the family were two grandchildren of primary school age. As well as this, five young, male tenants rented rooms in the house and paid 80 soles (£13.70) a month each from the money they made selling handicrafts to tourists in San Blas. Another tenant couple also lived in, with the woman working as a domestic help for the home owners and her partner working in a restaurant. Clearly, the main physical asset in this case was the sheer capacity of the house to accommodate paying tenants and adult family members. It also ranked high on other indicators with concrete floors inside the house, a drained concrete patio and a mixture of tiles and corrugated iron roofing.

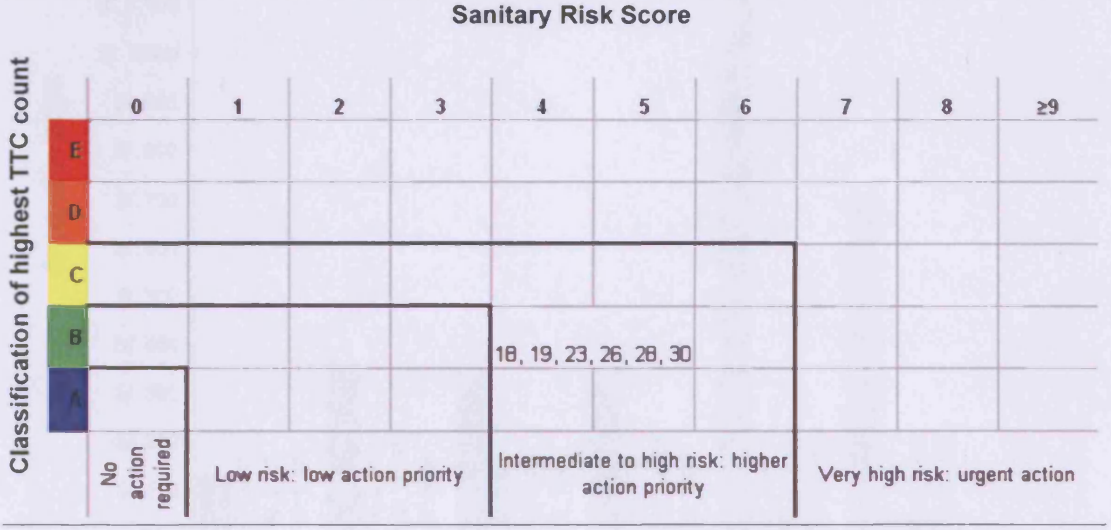
Last in this category, the female head of Household **26** had not completed her university education and did casual work selling street food. She was based at home and relied on income from other adults living in the house: two siblings (teachers) and two grown up children (a technician and a student working in a restaurant) all of whom brought in about 500 soles (£86) per month. In this case, the asset value of the house was a bit lower: it was older, built of stone with a corrugated iron roof and an un-drained and unsealed patio.

The sanitary risk scoring exercise placed all the households in this group in the same cell on the chart, classifying them as representing an intermediate risk because thermotolerant coliforms were present in stored water samples.

Table 18 Households and Taps in Entrepreneurial Group, San Blas

HH 18 'houseful of teachers'	HH 19 'market seller and elderly mother'	HH 23 'landowner-landlord'	HH 26 'street seller and teachers'	HH 28 'jeweller'	HH 30 'landlady'
13 people, 1 tap	8 people, 1 tap	16 people, 4 taps	6 people, 2 taps	4 people, 2 taps	9 people, 9 taps
					

Figure 33 Sanitary risk score in Entrepreneurial Group, San Blas



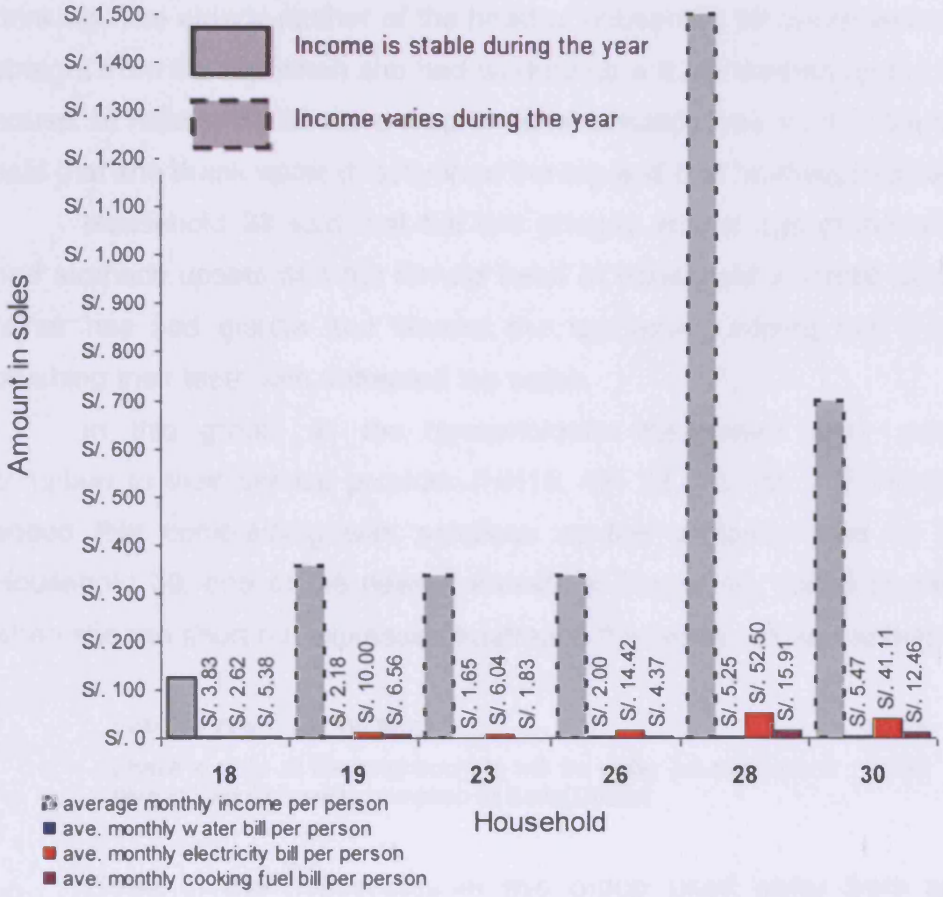
One of the characteristics of this group is the income insecurity associated with their livelihoods. This was most evident in Household **23**, whose income varied seasonally because of dependence on agriculture, and in Household **30**, where the income was tied to tourism. By letting rooms to foreigners, the head of household **30** was able to bring in income but this activity appeared to bring with it extremely high electricity bills[84]. This bill was only exceeded by Household **28** where the supply was used to run three phase grinding and polishing equipment for jewellery making. Household **28** generated income by selling specialised, "manufactured" goods to foreign markets. This

[84] Water bills in this household are not correspondingly high because the water is not metered

income fluctuated but it was buffered by not relying only on the local economy. The lowest household income per person in this group was reported in Household 18 where monthly earnings were stable, derived from the formal public sector by the adults working as teachers but divided among many of the young offspring.

Although households reported income instability, the average monthly incomes that they reported were relatively high, peaking well above those in either of the other San Blas livelihood categories or case study sites.

Figure 34 Monthly income levels and utility expenditure per person in Entrepreneurial Group, San Blas



Household 30 paid a fixed monthly bill which assumed a fixed consumption of 20m^3. She based her estimates on the volume of her water tank and the number of containers used for laundry, which matched up with mine made on the same basis. Other households, despite regular volumetric billing, underestimated water consumption. Daily billed consumption per person ranged between 45 litres to 140 litres with only unmetered Household 30 prepared to make an estimate at 190 litres.

Households **28** and **30** distinguish themselves again in their use of water. While other households in this group used water for domestic purposes only, HH**28** used a small amount for cleaning stones and machinery in the workshop (estimated by the head of household at an 18 litre bucket per day and 3 glasses per week respectively). Household **30** used water for making adobe bricks and mixing cement but "only for our own house". It is true that these building materials were not sold on but they were used to expand the house, which changed from week to week, to accommodate extra income-generating tenants. Indirectly, this use of water was linked to important livelihood activities.

Households **18**, **23**, **26** and **28** all claimed to boil their tap water for drinking. The elderly mother of the head of household **19** confessed to drinking straight from the tap when she had worked up a thirst walking up the hill to the house. In Household **30** the entrepreneurial landlady was much more blasé and said that she drank water directly from the tap and that "*nothing bad happens*".

Household **23** said that the two primary school age grandchildren had had stomach upsets and the female head of household in HH**26** said that her father has had giardia and blamed the tap water, adding that it was from brushing their teeth with untreated tap water.

In this group, all the householders interviewed were prepared to complain to their service provider (HH18, 19, 23, 26, 28, 30). Household **26** added that complaining was pointless as the company paid no attention. Household **30**, one of the newest arrivals to the barrio, called on neighbours when she ran short but expressed frustration that some refused to help her.

I would have to call the service	HH28
I have to go to all the neighbours to ask for water but some won't give it! I would have to complain to Seda[Cusco]	HH30

Three of the households in this group used water from alternative sources to supplement their formal supply:

If we are desperate, we use dirty water to flush the toilet: there is a pool in the plaza	HH19
We collect water in the rainy season to wash clothes	HH23
I have to go to all the neighbours to ask for water but some won't give it! Sometimes I go by car to get some from somewhere else, (from a house in the industrial park, it was mine but I sold it to buy this place and now friends live there)	HH30

Household **23** was collecting rainwater from the corrugated iron section of their roof.

Binding these enterprising livelihoods were slightly precarious financial assets but strong or developing human capital with extended, well-trained adult households or younger families still involved in education, a strong physical asset in terms of space that could be rented, filled with capable adult relatives or used as workshop space.

5.1.3 *Excluded Livelihoods*: precariousness

Although the households in the Entrepreneurial Livelihoods group suggest that a precarious primary income is linked to a more diverse set of livelihood strategies, what we have not seen so far in San Blas are the families that are unable to capitalize on their assets or simply have fewer to count on. In San Blas Households **16, 25** and **29** fall into this Excluded Livelihoods category.

For these households, human capital is palpably weaker. The education levels of the economically active household members were no higher than a completed secondary education. Although in Households **16** and **25** the children of the next generation were enrolled in full-time tertiary or university education.

The breadwinners in Household **16** were both on the margins of formal employment. The head of household depended on insecure seasonal work in construction and said ruefully that at that time of year (the rainy season) it was a case of "*casi propina*" or "practically begging". His wife worked on a casual basis in the local fruit and vegetable market[85]. When business was good, they could both expect daily earnings of about 15 soles (£2.60). This was a large family with 8 children and 2 grandchildren living crowded together and though the family owned their tiled, adobe house and had lived in it for 36 years, it still had earth floors and an earth patio with only rudimentary drainage. The principal tap was a rickety standpipe which gave directly onto the yard rather than into a sink. Unlike the households in other livelihood groups, Household 16 was using kerosene for cooking rather than bottled gas.

In Household **25**, the widowed head of household was not working and relied on letting out space at the front of the house to a third party who had converted and ran it as an internet café. This yielded 180 soles (£40) a month

[85] Specifically, not used by tourists but aimed at residents

with other sources of income coming from her children – both employed in the tourism sector, one in a restaurant and one as a guide – who gave her "a bit every day". She had lived in the area for 27 years since marrying.

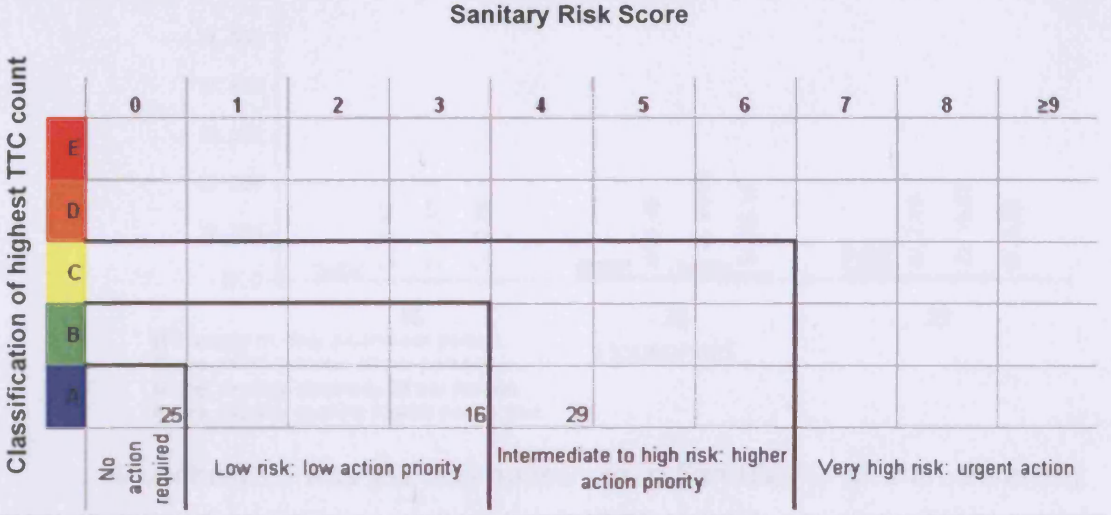
The family in Household **29** moved between Cusco and Puerto Maldonado[86] where the head of household worked as a taxi driver earning about 400 soles (£69) a month. The house itself was shared and split up into separate households for nuclear units of the extended family. This generation of occupants had been born in the house. It was a tiled, adobe house with wooden floors and the principal tap was built in and gave into a cement basin. As with Household 16, this family chose a cheaper alternative fuel for cooking but in this case firewood.

Sanitary risk scores ranged from zero in HH25 to four in HH29 but no thermotolerant coliforms were recorded in any of the water samples so overall risks varied from very low to intermediate. Household 16 had the most rickety standpipe in the group with a small earth patio with no drainage.

Table 19 Households and Taps in Excluded Group, San Blas

Household 16 'practically begging'	Household 25 'letting internet space'	Household 29 'moto-taxi in Puerto Maldonado'
12 people, 2 taps	5 people, 2 taps	6 people, 1 tap
		

Figure 35 Sanitary risk score in Excluded Group, San Blas

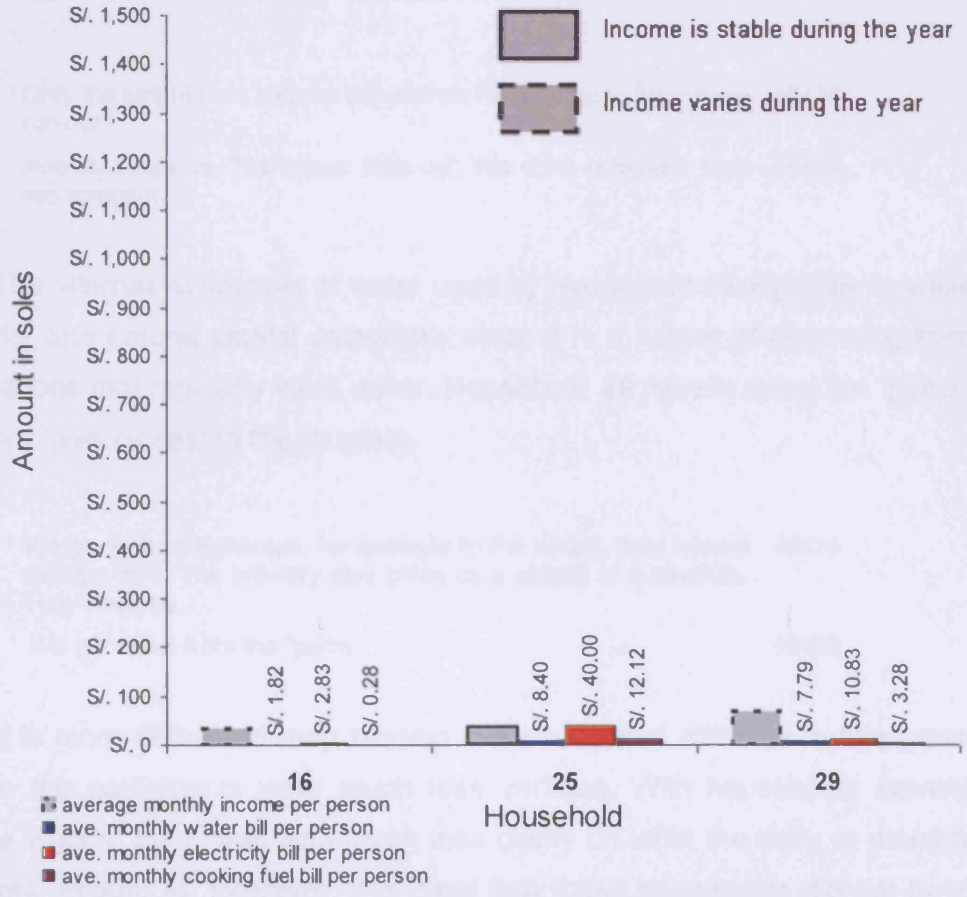


[86] In a neighbouring province to the east in the rainforest.

Household 25 reported income stability but the other households said their earnings were not stable through the year. What is significant though is the low level of earnings compared with the best-off households in the Entrepreneurial and Establishment Livelihoods. Incomes per capita in this group are markedly lower than in either the established or entrepreneurial livelihood categories. To make matters worse, there is also seasonal variation either because of a dependence on work in construction, which grinds to a halt in the rainy season, or the vagaries of tourism.

The high electricity bill in Household **25** is because the supply to the adjoining internet café is included. Household **16** has a low cooking fuel bill because the family does not use bottled gas but the cheaper alternative kerosene.

Figure 36 Monthly income levels and utility expenditure per person in Excluded Group, San Blas



Household 25 was the only household in San Blas to give an extremely high estimate for water consumption, at 2,000l/p/d, and even when the question was rephrased and we worked it out together, the water volume concept was

not relevant to this elderly interviewee. The other households underestimated consumption at less than 5l/p/d compared to 55l/p/d (HH16) and 175l/p/d (HH29).

The use of water for livelihood activities is also limited. Only in Household **29** did any householders describe other uses:

> We water plants but with water from the "perro" HH29

The three heads of household in this group all boiled water before drinking but in spite of this extra precaution, Households **16** and **29** reported water related illnesses. In HH**16** this was the occasional stomach upset and in HH**29** the head of household reported salmonella, although attributing this directly to the water supply is tenuous.

Household **25** said that they would complain to the water company but the other two households thought that complaining would have been fruitless:

> Only the neighbours help us out and we have to go to them if we run out. HH16
>
> Nobody helps us. The mayor robs us! We don't complain; they are arrogant. HH29

The alternative sources of water used by Household **16** arguably straddle the social and natural capital categories since it is a matter of borrowing from organisations that regularly store water. Household **29** reports using the "perro": this family lives closest to the fountain.

> We go to the neighbours, for example to the hostel, they have a storage tank. The brewery also gives us a couple of bucketfuls. They know us. HH16
>
> We get water from the "perro". HH29

It is more difficult to map binding livelihoods and attitudes in this group because the participants were much less verbose. With households earning insecure wages, there was also much less clarity on what the daily or monthly rate might amount to. However, it is clear that these households did not have the human or financial capital of the others and although Household **25** was letting out space and using a physical asset, operation of this business was left to another entrepreneur.

5.2 Vulnerability Context

San Blas is considered an important barrio in Cusco's heritage and it is included with two other zones, Santa Ana and San Cristobal, in the provincial municipality's plan for the historic centre (Municipalidad del Cusco & Instituto Nacional de Cultura 2006). It is still known as the artisan quarter and is popular with tourists because of its cobbled, pedestrianised streets and colonial buildings. Indeed 70% of the artists living in the historic centre have what are known as "viviendas talleres" where they still live and undertake their craft (Municipalidad del Cusco & Instituto Nacional de Cultura 2006):52.

San Blas was one of several barrios identified as vulnerable by the local NGO "Centro Guaman Poma de Ayala" in their 2002 *Estudio Catastro* (Estrada 2002).

> The vulnerable groups and those exhibiting the highest levels of social and physical deterioration in the historic centre – such as overcrowding, physical insecurity, inadequate or obsolete services, as well as poverty and a lack of economic resources amongst the population – are found in the traditional sectors at the edge of the city centre and correspond to the barrios we refer to [among which is San Blas]
>
> (Estrada 2002)

CGPdA's conclusions were based on a series of surveys and an enumeration of slum dwellings. Nearly a third of slums in the historic centre were found in San Blas and of a population of 6,739 people (based on 1993 census) 3,513 were living in slum conditions[87]. The aggregate figures across the historic centre for the type of tenancy are also revealing, with 33% owner occupied, 53% rented and a further 10% insecure in some way and used as either guest houses or squats. The report also estimates that in 1997 about two thirds of the population had adequate services and of the remaining third:

[87] CGPdA has helped 35 families in San Blas (Centro Guaman Poma de Ayala Interview 6 2006). Despite being in the historic centre and a tourist hub, there can be as many as 3 families sharing a latrine and standpipe. CGPdA's interventions to ease overcrowding are hampered by the fact that the INC has aesthetic requirements in this urban zone. During household interviews and the group session, the community identified lack of water during the afternoon, competition for water between residential and commercial users and dilapidated buildings and installations. The constrained access to the zone because of the steep, narrow steps, described nicely as "*accidentado*" (HH24 Household Interviews).

15.2% have communal water and waste water, 10% have only one of these services and 10% have neither[88].

The Centro Guaman Poma de Ayala treats San Blas as a zone delimited by Quiskapata, Choquechaka (to the right, to the left is San Cristobel), Tulluymayo, Quollacalle, Pumaccpampa [89]. This is shown on the aerial photograph below in yellow. The area is identified on the risk maps developed for the 2006 urban development plan (Municipalidad Provincial del Cusco 2006) as prone to flooding during heavy rain.

In San Blas, none of the households themselves had much to say about natural hazards[90]. Household **24**, in the Establishment Livelihood group, was alone in mentioning earthquakes and she attributed her awareness to training courses on classroom evacuation that she had been sent on as a school teacher. She dismissed the local risk by claiming that *"San Blas was built on rock and felt earthquakes a bit less"*.

[88] On the basis of this survey, CGPdA went on to intervene in 35 households in San Blas. CGPdA also reported up to three families sharing a silo (latrine) and a single tap (Centro Guaman Poma de Ayala Interview 3 2006).

[89] The parish boundaries still seem to have a place in people's hearts and it was clear during the group session that some of the older residents were unhappy that CGPdA and I had delineated San Blas as just a small zone in the historic centre. The president of the neighbourhood committee said that the real San Blas extended to Pisaq in the North. the Rio Huatanay in the South, to the Salineras de San Sebastian in the East and Siete Moragitos in the West. (San Blas Community Meeting 2007)

[90] A few households mentioned lightning but this was at the front of people's minds because the interviews were conducted in the same week that lightening struck the bell tower of the church in San Blas Plaza bringing down its stone cross.

Figure 37 Location and risk map of San Blas

5.2.1 Security and tourism

A variety of vulnerabilities came up in the interviews. The first set of concerns was linked to tourism. Several households in the Establishment and Entrepreneurial Livelihoods categories were unhappy about the boom in tourism that had taken place over the previous 10 years. Household **17** claimed that it had forced people to sell up and move out and argued that San Blas ought to have been kept residential since it was no longer as "tranquilo" as it once had been. Household **24** made the link between tourism and the pressure on traffic, making a case for access to the plaza to be limited to authorized vehicles only.

Similarly, in the Entrepreneurial Livelihoods group, Household 28 and Household 26, whose head of household had born in the zone, wanted the tourists to leave rather than displace long-time residents.

> Lots of foreigners force us out, I'd like them out HH28

These households either worked outside San Blas or, in the case of HH28, sold their wares to dealers abroad and not on the street or in the local artisan markets, in other words, their livelihoods were less dependent on tourism perhaps justifying the hostility to tourists. Yet even households in the entrepreneurial group with a strong livelihood link to tourism, through tenants (HH18) or an internet café (HH23), were concerned about the tourist influx and the local inflation it precipitated.

> 3400
> The problem for me is that it is completely touristy, it's ""full", it should be controlled so that the plaza doesn't get congested HH23

Only the 'establishment' female head of Household **22**, whose livelihood was linked to tourism via her tenants, was concerned about tourists being discouraged from coming to San Blas. She was worried about street crime:

> [Crime] gives a bad impression where tourists walk around HH22

In fact, crime was a second important source of stress in San Blas, with households in the Entrepreneurial and Excluded Livelihoods groups reporting that they had been victims of crime:

We have [problems]! They have already broken into the house	HH23
We've already been robbed!	HH29

Rather than worrying about tourists avoiding San Blas, entrepreneurial Households 18 and 26, explicitly blamed crime on the presence of tourists:

Because it's a tourist zone, sometimes there are lots of assaults	HH26
It's a problem, there are lots of thieves and criminals because of all the tourism. Too much tourism, it is worse and things cost more	HH18

In the Excluded Livelihoods category, the main stress on household livelihoods is insecure, seasonal income and this affected their ability to participate in collective efforts against crime:

It's not that safe, I don't pay and they [private guards] don't come	HH16

Beyond tourism and crime, the expense of renovating colonial houses in the zone was mentioned by entrepreneurial Households **18** and **23**, as well the excluded Household **25**, who worried about the annual rain damage to her adobe house and the expense of fixing it:

I'd like it if we got help to rebuild the houses, we can't fix up our own houses	HH18
We are still only half finished, we have a loan to do it	HH25

Other stresses such as poor services like transport, the police, waste collection and the distance to the nearest health post were flagged up by Household 23. For HH23's only adult family member without a tertiary education, the transport priority was linked to making schools more accessible and she emphasised the need for better education services by saying that she would spend money on a good nursery school for a solid "*educación inicial*". Transport related stress was also mentioned by Household **29**[91] in the excluded category.

[91] This family lived in a house which gave onto a narrow cobbled street with a thin strip of pavement not wide enough for people to pass each other. The street is a thoroughfare and traffic races down it.

For this couple, parents of school aged children, the priority was to "*go back to a pedestrianised street*".

Regardless of livelihood group, householders expressed concerns about tourism, crime and traffic. Those expressing concern at the annual rain damage to their houses tended to have weak physical assets, earth patios without adequate drainage but the impact of overflowing drains in the street depended on location rather than livelihood.

5.3 Infrastructure and Services

For the district of Cusco as a whole, the dominant fuel for cooking in the 2005 census was gas at 60%, with kerosene and firewood at 13% and 17% respectively. In the sampled households in San Blas, two households in the Excluded Livelihoods group reported using these cheaper alternatives, otherwise bottled gas dominated.

5.3.1 Energy

In both the Establishment and Excluded Livelihood groups, interruptions in the electricity supply were accepted patiently with householders simply waiting them out. Household **27** claimed that the electricity company was more likely to deal first with problems in the main plaza or the wealthier Wanchaq District, taking longer to get to places outside the centre of town. He also said that: "*before we used to have power cuts all the time in the dry season because there wasn't enough water to run the generators, now it's really rare.*"

By contrast, in the Entrepreneurial Livelihood group, a number of householders said that faced with service interruptions they would go to the electricity company or complain. These people had a livelihood interest in an uninterrupted supply: HH**28** the jeweller who had paid for a 3-phase connection for his machinery, HH**30** the entrepreneurial landlady, HH**19** with two tenants and HH**18** which ran an adjoining internet cafe.

5.3.2 Solid Waste

The system for collecting household waste in San Blas is set up so that people deposit their rubbish early on Monday, Wednesday and Friday mornings. In some areas of the city, household waste is brought to containers but in San Blas it is left exposed and although the piles of festering rubbish are usually collected before 10am, by that time dogs and vermin have already had time to raid and spread it. There are certain locations (shown on Fig), at the bottom of the steepest streets, that are accessible by a nimble waste collection vehicle: sacrificing capacity for manoeuvrability.

In the Establishment Livelihood group, Households 22, 24 and 27 were frustrated by fly-tipping which they blamed on outsiders. In the Entrepreneurial Livelihoods group (HH18, 23, 26), the culprit was more explicitly the inadequate waste collection service:

Cusqueños never used to do this kind of thing, it's a habit from Lima	HH24
[Rubbish trucks] should come every day because there's a big population and tourism. It's a tourist zone and it's crowded	HH27
People bring rubbish from other places and dump it	HH22
There is no fixed timetable [for collection]	HH18
The rubbish trucks are only small and they can't collect everything people put out so they leave it behind at the corner, the rubbish gets left behind	HH23

Households in the Excluded Livelihood category expressed much less dissatisfaction with the service and also claimed that they did not generate much rubbish:

The trucks come and we wrap rubbish in plastic bags, otherwise we would be causing pollution. If the trucks don't come, we go to the containers up the hill. No problem.	HH16
The trucks come regularly. We collect all the rubbish but there isn't much	HH25

In the Establishment and Entrepreneurial Livelihoods groups, a number of households were concerned that waste was not separated (HH24, HH27, HH28).

It goes in the truck, all mixed up: solids, organics, plastics	HH24
It should be sorted and recovered	HH28

The households with experience of burying, burning or making use of household waste as compost were those with access to suitable space elsewhere; a large, unsealed yard; or a rural upbringing:

Before, we used to burn it in the garden because the service came less often	HH26
Before, I used to sort it out and then after that I buried it in the ground. If the trucks don't come we go to the big containers on Lucrepata and Titicaca [nearby streets].	HH30
In the country, we had a pit for organic waste, to make compost. With the plastics, I don't know, there's no way to deal with it. They cause pollution	HH24

Independent of livelihood category, none of the households interviewed in San Blas knew where their solid waste ended up. In all categories, there were households that identified *"places in the hills"* or *"the country"* (HH17, HH27 and HH29). While in the Establishment and Entrepreneurial Livelihoods categories a few households mentioned the municipal tip (HH22, HH18, 26, 28 and 30). The rest, in the Entrepreneurial (HH19, 23) and Excluded (HH16, HH29) categories, said that they had no idea where their rubbish went.

5.3.3 Waste Water and Storm Water

When it came to the destination of waste water, Household **24** in the Establishment Livelihoods category, was the only person in the San Blas interviews to acknowledge that waste water ended up in the River Vilcanota and to express dismay at this. This may have been linked to her oft cited youth in the countryside and subsequent migration to the city on marrying:

> [it goes] into the street [and then?] to the River Choquechaka and then the River Huatanay and then after that the Vilcanota. Well, my view is that it's completely awful. It shouldn't go into the river. HH24

Otherwise, whether or not households mentioned the River Huatanay as the final destination of their waste water was not linked to their livelihood group[92]. Household **16** in Excluded category was the only one to mention the treatment plant.

Several households reported localized problems with foul water and the overflow hazard caused by heavy rain and blockages in the system, including HH17 and HH22 with Establishment Livelihoods, HH19 in the entrepreneurial group and HH25 in the excluded category. The impact on these last households was made more acute by their location at the bottom of a steep cobbled street, with only a shallow, open drainage channel in the street to convey water into storm drains[93]. The effect of the torrential rainwater that *"comes from up the hill"*(HH25) was compounded in these households by their adobe construction:

---

[92] The River Huatanay was mentioned by all except established HH **17**, entrepreneurial HH**26, 27** and **30**, excluded HH**25**.

[93] The run-off has an incredible flow rate and just getting patios to drain fast enough can be a battle

It is really bad, we get flooded, it overflows, gets blocked by soil and rubbish. The street is a river, it stinks. The manhole comes off and it stinks.	HH17
The manholes fill up with rubbish and waste water comes out. And the manholes get stolen.	HH22
Sometimes they get blocked up in the street. When it rains we get flooded out. Last year a wall fell down and we had to move into a different room.	HH19

Again location rather than livelihood group was behind the households that thought larger diameter sewage pipes ought to be installed (establishment HH24, HH27, entrepreneurial HH18, HH30 and excluded HH29). Household **30** had water and sanitation high on her priority list: her livelihood depended on letting rooms to water-guzzling foreigners and her multi-storey house had problems with drain blockages.

Because we are higher up, we need bigger pipes. They get blocked	HH30

SEDACusco's maintenance of the system was criticized by Households 22 and 16 in the establishment and excluded groups respectively.

5.3.4 Water

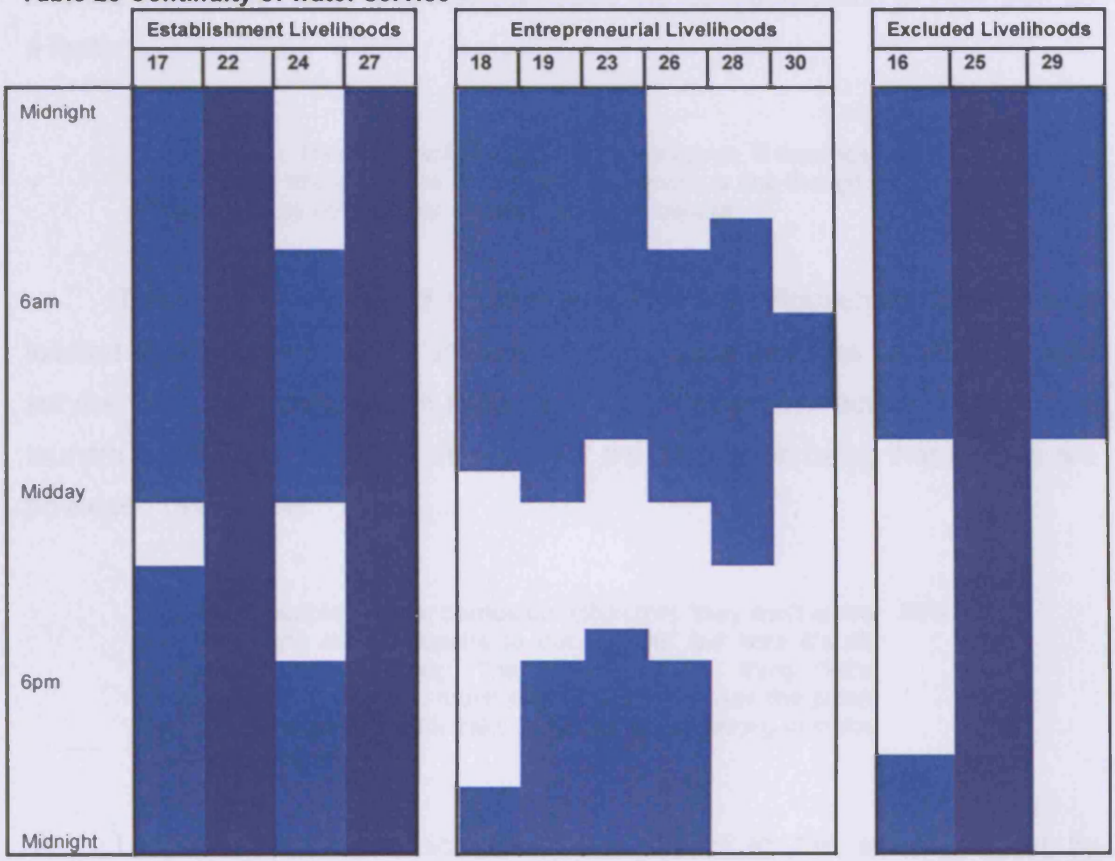
Across the District of Cusco, the percentage of households with a water supply connection inside their house stayed at 47% between 1993 and 2005. The percentage with connections within the demise increased from 32% in 1993 to 40% in 2005: an overall increase in coverage from 79% to 87%. The increase in coverage of sanitation was similar with the percentage of households connected to the sewage system increasing from 81% to 92%. These figures do not reveal anything about drinking water or waste water treatment, the service provider or the quality of service.

The daily water service experienced by households in San Blas is characterised by regular afternoon interruptions regardless of livelihood category with households with continuity located in the water company's neighbouring pressure zone (HH **22** and **27**).

Household **30** reported the shortest period of daily water provision and was the highest household in the sample and thus at the limit of the water

company's pressure zone. The water company had agreed not to install a meter in this household[94].

Table 20 Continuity of water service



As for "irregular" interruptions – extra to the everyday cuts expected by residents – various households across the groups did not report any irregular interruptions (HH**22** and **17, HH 18**, **19**, **23** and **26** and HH**25**). Estimates among households reporting interruptions ranged from 20 times a year in establishment Household **24** to between 4 and 6 (HH27, HH30 and HH16). Excluded Household 16 did not know how many times the service stopped:

> There are cuts about 20 times a year, maybe for a day. 20 days ago there wasn't any water for 3 days but we still pay the same even when the service breaks down, I buy water for washing hands. HH24
>
> From time to time there are interruptions, the last one was the other week but I don't know how many times a year, maybe for two days each time. HH29

[94] Partly because of the poor supply pressure and, according to the head of household, the fact that air was whistling through the meter when the water was off. HH**30** installed a storage tank and paid a fixed fee regardless of consumption.

When views about the lack of water were sounded, location was perceived to be a factor. Household 17 linked the interruptions to the source and the treatment plants and acknowledged the central location of San Blas as a factor:

> I don't know. There's a lack of supply from the plants, it depends on the rains and it's worse in August. The service is fine though. They probably don't cut us off because we're central — HH17

This idea of privileged location is echoed by Household **22**, which is located in a separate, lower altitude pressure zone and has an uninterrupted service. This time the location factor is linked to economic activity in the zone: tourism is a reason not to cut off supplies: the implication being that tourists are privileged over locals.

> I've heard people in other barrios complain that "they don't serve us, they don't do the repairs to our system" but here it's ok because it is so touristy. The pressure is the thing that's inconvenient. There's so much pressure it can break the pipes and it makes you scared to take a shower, it's so strong in make the solder pop off — HH22

Location and economic activity are linked to the service again by Household **27**[95]. For the head of household in this case, the tourist centre will be prioritised over the peripheral areas. This view was shared by two households in the Excluded Livelihoods group:

> Within the centre, in the hotels, it doesn't suit them to have their water turned off but on the edges there aren't any hotels. Those in the centre should collaborate with those at the edges but I'll pay a bit more so that the others pay less; it suits me, that's all. I had to pay myself to mend the valve because they break down every 2 or 3 months – the quality is so poor. — HH27
>
> There is a shortage because of excessive consumption in the centre. — HH16
>
> It depends on the rain. There should be a [separate] system. It shouldn't supply the [central] Cusco system. Because it's an archaeological zone it's really expensive. Straight away they cut you off and make you pay for it. — HH29

In contrast, the establishment Household **24** in the higher altitude pressure zone, blamed tourism for the shortages a change which this household had been able to observe over many years:

> Before, it wasn't like this: there was never a shortage of water. Ever since it's been more crowded, there hasn't been water because of the tourism and the restaurants. I think that there are lots of hotels with cisterns and tanks, it gets used up. I heard that there are at least seventy [hostels] in San Blas but that's unofficial information ("datos extraoificales"). It is a problem: sometimes you're having a shower and it cuts out in the morning when you're covered in soap. As two people we find it tough but it must be worse when you have children. The service is terrible for something so important. HH24

Households **18** and **19** identified population growth as the reason for the rationing.

> There are more people, that's why there's no water. I don't know. They shouldn't cut us off: in my view, no water means no life HH19
>
> The service has got worse. Before it never ran dry but there is rationing and population growth HH18

Across groups, households noted that service restrictions had been introduced (HH17, HH18, 26, 28, 30, HH25, 16). In the establishment group, Household **17**, fairly new arrivals to San Blas, reminisced about the untreated (and, by the sounds of it, unimproved) water sources that he used in the 1980s:

> Twenty years ago, we went to las pacchas[96]... ages ago. There was a stream in the alley when I was really tiny. Now with the restrictions... before they didn't restrict it HH17

Household **30** pinned down the timing to a deterioration in service that had begun 5 months before. This coincides with work on the main line into San Blas (but also with seasonal changes):

> It changed 5 months ago, it was on all day but now it's not HH30

[96] "paccha" translates from Quechua as "cataract" or a source or spring.

Outright hostility to the water company was expressed by Households **19**, **23** but otherwise the heads of household were resigned to the fact that there was not enough water to go round:

> [SEDACusco] doesn't explain anything to us! In the past it never ran dry. Three years ago a pipe burst in Tandapata and since then there have been problems. It's a terrible service. We can't wash ourselves very early in the morning because it's so cold. It never used to run dry. Before we paid 9 to 12 soles (£1.50 - £2.00) and now we pay 26 to 29 (£4.50-£5) even though we don't have water — HH23

In the excluded group, Household **25** shrugged that the service was "muy buena" despite being furious about it informally and outside the interview setting. He did concede though that:

> Before, there was more water. I don't know why. — HH25

In the Establishment Livelihood group, household water storage was not considered necessary (HH17, HH22 and HH27) except in Household 24 where the head of household admitted that recently she had begun to store water.

> Since we have water every day, not much [is stored] — HH17

All other households in the Entrepreneurial and Excluded Livelihood groups, admitted to storing water for 24hours (HH18, HH19, HH23), 48hours (HH16) and 72 hours (HH26, 28). Stored water was used for laundry (HH18, HH30) and toilet flushing (HH18, HH16) and, where it was stored in covered containers, it was used for cooking (HH26 and HH16). Households reported using open containers (HH18, HH19) and covered containers (HH23, HH26, HH28, HH16).

> Yes we store because the supply dries up. On a daily basis, we use drums, a storage tank designed for water storage and when we do the washing we use buckets and "tinas" (containers made out of old tyres). These are filled with a hose — HH30
>
> We store because the tap runs dry. Every day we use a 50-60l drum with a lid and another without a lid and we have a 40l container on the roof to collect rain water. We fill them every day with a hose and keep the water for a day — HH23
>
> Just in case we store water in buckets with lids but we don't use it for drinking water unless it's fresh. We store it for 3 days. — HH28

Household 29, in the Excluded Livelihood category, mentioned storing water from "el perro":

Sometimes, when it goes off, we use water from the "perro" and store it for a few days in an 18 litre bucket with a lid.	HH29

Opinions over the cost of service were divided. Some households were happy with the cost and interestingly they spanned the livelihood groupings (establishment HH17, entrepreneurial HH18, HH30 and excluded HH25):

Since it's metered, it is exact.	HH17
Yes I am okay with the price since there are several families living here. If we don't pay, they cut us off within 2 months	HH18
Yes I agree with the cost. Since it is indirect [there is no meter]. Because the water isn't on all day and the air makes the meter run. The engineer from SEDACusco said that I didn't have to have a meter.	HH30

Household **24**, in the Establishment Livelihood group, agreed with the cost on her own behalf but railed against it on behalf of the worst off:

I agree with the cost, an amount like this, given that the service is irregular, it's vital, it has to be affordable. They cut us off automatically in the second month, they fine you 29 soles (£5). It's an attack on our poverty, a punishment. If they don't pay, it's because they can't!	HH24

Two other households in the Establishment Livelihoods group objected to the cost because they claimed that their water meters were miscounting and charging them when air rather than water raced through the pipework (HH22, HH27). Household **22** which had the highest monthly water bill per person in this group was unhappy about the service cost:

No way. It's too much. The air makes the meter run.	HH22
It's a lot to ask, it works out very expensive for me. And it isn't exact: sometimes air runs through the pipes, it whistles, sounds horrible. [The cost] doesn't match up with the real consumption. If we consume more, they charge us more. When there are babies, we use lots of water to do laundry all the time. Here it is the SEDA system and they'd cut off my water [if I didn't pay]	HH27

In the entrepreneurial and excluded group, households felt that the price was high (HH19, HH16), or too much for the amount of water they actually used (HH23, HH28) and that the prices had gone up (HH26). Household 28 even compared the costs to the parallel administration further up the hill:

> I'm not that happy about the cost of water because we don't consume much. For example in Villa San Blas, up the hill, they pay 2 soles (35p) per month for water from a spring. HH28

There were also comments on the cost related to the water quality from the Establishment and Excluded Livelihoods groups:

> It's really expensive, it's essential and it leaves a lot to be desired. For example, better treatment... Let me explain it to you: in the morning during the rainy season, the water is turbid, dark. In the dry season, it is "blanco" [clear] and it has chlorine in it. It gets worse all the time: they help people with money, the big businessmen... HH29

What emerged from the interviews is that householders perceived their location in the SEDACusco system to be important and related to their quality of service. There was the sense that central, tourist areas were privileged and that heritage areas were more expensive for the water company to service. Householders expressed the idea that there might be competition for water within the SEDACusco system, higher demand created by population growth and tourism and consequently rationing and restrictions imposed by the water company.

Householders turned to household storage, rainwater collection and public fountains, like 'el perro' in the face of water shortages. They also objected to what they perceived to be high water costs because they felt their consumption was low, their meters gave faulty readings and the water quality was poor.

5.4 Paths to Influence

In the district of Cusco the state remains involved in the provision of education, healthcare and policing. The national government's *Instituto Nacional de la Cultura* (INC), charged with safeguarding heritage sites, is also an important actor with its aesthetic requirements imposing significant extra

costs on the repairs to old colonial houses (Centro Guaman Poma de Ayala Interview 6 2006).

The nearest primary and secondary schools were at the foot of San Blas, seven to eight blocks away for the highest residents and a block or two for those lower down the hill. The nearest health centre was much further away. Although there was a private clinic just next to the plaza in San Blas, the nearest health centre was in the Wanchaq District, ten to fifteen blocks away and more than 25 minutes by foot. The tight road network meant that the nearest bus stops were at the base of the hill.

CGPdA makes a general comment about the prospects for development reaching those most in need when Enrique Estrada notes that:

> The current, centralised political context, is still not good at getting resources to an integrated programme of recovery and rehabilitation of the historic centre that might improve living conditions for the traditional, resident population.
> (Estrada 2002)

5.4.1 Central Government

The household interviews brought out various attitudes to the state. The INC was mentioned by HH17 in the Establishment Livelihoods group. Even for this relatively income-stable household, potentially with the resources to upgrade their dwelling, restoring a colonial house within the constraints set out by the INC was an expensive and intimidating undertaking. In the Establishment Livelihoods group, whether they were satisfied with it or not, was a residual expectation of the state.

Common across the livelihoods group was a disappointment with the police service. In the Establishment Livelihoods group, householders' expectations of the state had been moderated by the practical reality, where, at least in terms of security, the neighbourhood had taken matters into its own hands. Making reference to the very local efforts to tackle crime, Household **17** reflected popular cynicism and HH**24** explained that:

The police come but they don't exactly rush	HH17
We have agreed that we have to pay a subscription for security guards... although in theory it is the responsibility of the state	HH24

In the Entrepreneurial Livelihoods group, only the newcomer, Household **30**, seemed confident that the police would come if called. Other households were adamant that the police would not help them (HH18 and HH19):

> They don't come, they don't take any notice HH19

A distinction was also made between the regular police and the tourist police, the latter being highly visible in San Blas:

> The tourist police have started coming... we demanded a service but the tourist police is just for tourists! HH23

For the Excluded Livelihoods group, apart from Household **25**, located closest to the plaza and within clear sight of the parking spot used by the tourist police at night, who said that "*these days* [the police] *come*", the other households were dismissive of this state support (HH16, HH29):

> We reported [being robbed] but they [the police] haven't done anything HH29

Education, another nationally delivered service, was brought up by the old-timer accountant in the Establishment Livelihoods group (HH**27**). This comment followed the activist theme that wove in and out of most of his answers: that there was "*lots of ignorance*" and that people needed to understand political ideas because "*the mind changes first*", "*values have not been cultivated*" adding that people also needed "*food to fight*". As we shall see, the almost revolutionary language of this man's responses recurred and together build an account of suspicion and cynicism directed at the authorities. His daughter, nursing her tiny baby, put more weight on "*physical things*": "*that they might get rid of factories*" because of the pollution they caused and instead provide places for creative activities and parks.

5.4.2 Municipality of Cusco

It was two households in the Establishment Livelihoods category, the old-timer accountant and the teacher, who had the most to say about the

municipality. Both were dismissive about the results they saw from their local tax contributions:

> The authorities that we've got in Cusco are not bothered about public health. They promise miracles at election time but they don't care, right. This master plan, we don't know whether it's just a fiction or not — HH27
>
> The municipality is practically obliged to be doing something with the autovalor [local council tax]. We don't benefit from any of the municipality's public works. The householders face enough obstacles in trying to repair their own houses because it's expensive and the homeowners don't have any cash — HH22

For the households with Excluded Livelihoods, the role of the municipality did not come up. In the Entrepreneurial Livelihoods group, little mention was made of the municipality except in Household 23 – with its livelihood interest in agriculture and markets for fresh produce – where the head of household commented that:

> Daniel Estrada was the best mayor we've had — HH23

This was a reference to the tenure of Daniel Estrada, examined in Chapter 3, whose office spearheaded the regeneration of several of Cusco's markets and the plaza in San Blas.

In San Blas the dominant preoccupation is with crime. There is also a perception that they were not prioritised by their service providers. In the establishment group, residual high expectations of the state were disappointed and supplanted in the entrepreneurial group by local development initiatives.

5.4.3 The Neighbourhood Committee

The San Blas *Junta de Vecinos*, or neighbourhood committee, has been around for at least fifty years[97]. It is now legally recognized and, at least in theory, brings together several groups including the "association of new artisans in San Blas"; the parish (which already plays a part in neighbourhood integration); and representatives from various housing associations. The history of this organization is summed up in Enrique Estrada's study:

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[97] During the group session, the president of the neighbourhood committee said that he remembered having meetings as a child in the house of one of the older residents and that the barrio had always been well organised.

> In San Blas the neighbourhood committee has been formally constituted for a long time. Generally, it used to be run according to the personal interests of the board members. Today, one senses a degree of apathy among them and an indifferent attitude to working collectively, although there is concern and interest amongst members of the community who strongly identify themselves with the barrio... ...even if there really are leaders, the power to bring people together remains limited by the lack of integration of the population.
>
> (Estrada 2002)

Estrada's observations were reinforced during household interviews and the final group session (San Blas Community Meeting 2007). Participants in the group session questioned whether the committee was really a "strong" organization and explained that public meetings were held about five times a year but they were poorly attended, especially by the young. They also cited a history of long presidential terms and not much evidence that the budget ends up in community assets. The focus of much of the committee's energy is the Casa de Cultura which is being refurbished "to set an example to the rest of the city as a place that people can go to appreciate culture". As a priority for the barrio, however, this did not chime with the ideas that emerged from household interviews.

The level of engagement with the neighbourhood committee was patchy in the Establishment and Entrepreneurial Livelihood groups. In the Establishment Livelihood group, for example, Household **24** had a prominent role on the committee and stressed that the committee was needed to address problems of crime and bring together the municipality and the police. Other households in this group, however, were more sceptical with Household 17 feeling excluded and describing it as:

> ...just a group of mates, a closed shop HH17

Household 27 had been a long-time participant in the neighbourhood committee[98] but even he was dubious about the committee's efforts to tackle crime and had opted out of the neighbourhood strategy. His comments are consistent with his suspicious attitude to the authorities:

[98] During the group session, he was remembered by another Sanbleno as having hosted committee meetings in his house thirty or forty years.

I don't pay because [the security guards] check out who has "resources" and pass on the information to third parties. You can't trust them. They're ex-Army and they inform on people	HH27

The president of the committee, grouped in Entrepreneurial Livelihoods, emphasised that the committee had led the local response to crime and was keen to get across that the committee did not exist to burden people but rather *"so that people would feel better"*. He described the spontaneous local reaction to crime and then outlined the committee's official strategy to employ private security guards:

We have had [robberies]. All the neighbours ran out with sticks!	*HH28*

This strategy was confirmed by other households in the Entrepreneurial Livelihoods group (HH**18** and **19**) who said that there were occasional committee meetings:

There are robberies in San Blas. We are trying to sort it out through the neighbourhood committee	HH19

Meanwhile, in the Excluded Livelihoods group, engagement was almost non-existent. The interview with HH16, a household close to the bottom of the pile in this zone, painted a picture of exclusion from both the neighbourhood committee and formal employment. The plea from the head of household was for a "*more united people, so we can do something*". When asked what this "something" ought to be, he said "*something economic: services and businesses*".

Household **25** had not heard of the neighbourhood committee and Household **29** was dismissive of it:

They don't call us to meetings. There is a neighbourhood committee but I don't know anything about it. We participate in the elections but not in the activities because there aren't any meetings. There just aren't. The people are really...they don't take us into account.	HH16
The committee: it's really disorganized.	HH29

The neighbourhood committee continued to be built around the involvement of a few core people, with exclusion felt by individual households in all groups but complete disengagement in the Excluded Livelihoods category.

5.4.4 Civil Society: NGOs and CBOs

There are other Civil Society organizations operating in San Blas. These are distinct from the neighbourhood committee either because their geographical reach goes beyond San Blas or because they focus on a specific sector or cause.

The CGPdA has been involved in the restoration of colonial houses and improvement of sanitation in households that were still using pit latrines and flagstone channels. By 2006, all the families interviewed had a WC with sewer connection inside their demise, although the date of installation varied by livelihood group. The CGPdA targeted their projects at those least able to afford improvements and this meant that the households in the Establishment Livelihood group had not been beneficiaries. All these households reported that they had had waste water connections for as long as they could remember (HH24, HH27, HH17, HH22) but they were still all aware of this NGO's work. Households 22 and 24 were positive, calling CGPdA a "great NGO" and elaborating that:

> They are restoring old colonial houses and they come highly recommended. They are saving the heritage — HH24

The accountant in Household **27** expressed his by now familiar cynicism on the intervention of NGOs which he felt should be directed at the most marginal, the poorest families, and he deliberately excluded himself from this category.

> They don't do what they're supposed to do. It's something else, it's camouflaged, an institution that's doing deals with the municipality — HH27

In contrast with the Establishment Livelihoods group, a number of households in the Entrepreneurial Livelihoods group had been helped by CGPdA. In particular, Households **19** and **26** were favourably disposed towards the NGO because they had been given help to renovate their stone drainage

channels and install waste water connections. Others who had not been assisted occasionally knew about the CGPdA projects (HH**18**, HH23) but the prosperous president of the neighbourhood committee – obviously not a beneficiary – said of CGPdA that:

> They don't do much, only research and training and promoting their own centre — HH28

In the Excluded Livelihoods category, Households 25 and 29 were aware of CGPdA because they both had been supported to renovate their WC connections. Otherwise they were not aware of or participating in any organisations working in the barrio and said that they didn't know or hadn't seen any (HH16, HH29) or were not up to date (HH25).

Beyond the physical upgrades, the CGPdA was intervening in broader development activities and attempting to open channels for participation. Household 22 in the Establishment Livelihood group reporting that – despite being a relative newcomer to the area – she was the nominated representative for her street. Her job was to help *"get people involved"* by going door to door encouraging people to meet with CGPdA, although she admitted that it was a struggle to get people engaged. She mentioned that CGPdA was promoting ideas on ways to rent out rooms to foreigners and set up "*casas hospedajes*" or guest houses.

In the Entrepreneurial Livelihoods group, Household 26 mentioned the capacity building efforts of the CGPdA and the support to home-based enterprise, in this case urban agriculture:

> Well, I think they coordinate women in the zone via COMUZONE, they run workshops and helped me with my garden — HH26

CGPdA's influence was not regarded as universally benign, with Household 28 reporting that San Blas residents had wanted additional containers for solid waste but that CGPdA had objected for aesthetic reasons and this had discouraged the municipality from providing them. This highlights the tension between tourism, the amenity and cultural value of Cusco's heritage and the provision of municipal services.

In three cases, Household 24 with an Establishment Livelihood and Households 28 and 30 in the Entrepreneurial Livelihoods group, the households had set up their own, home-grown NGOs. For Household **24** this was the workshop for young, deaf women and although it had profit-making features that were difficult to pin down, capacity-building was a fundamental part of the exercise. Household 28, the jeweller and neighbourhood committee president, devoted his spare time to a group in Villa San Blas (a *comunidad campesina*, settled informally higher up the hill) called Sons of the House of the Sun (*los hijos de la casa del sol*). He worked as a 'motivator' or facilitator:

> We train people to work with machines as silversmiths and artisans in workshops — HH28

This role and his neighbourhood committee position mean that he had meetings with craftsmen, the municipality, the junta and the local NGO – all this took up so much time that to keep his own jewellery business running, his wife and children had to help in his workshop.

Household **30** was a founding member of an organisation for women called "*Hands Together*", which she helped to set up in Magisterio, one of the new, wealthy suburbs of Cusco in Wanchaq District.

> The aim is to sell our handicrafts in our shop. We bring together new ideas and each member has their particular skill. Me, I knit and I'm going to train people in that too — HH30

These pockets of collective action and training combined the capacity building aspirations of a development NGO with a role that could be described as "business development", straddling the Market and Civil Society spheres of governance.

The oldest householder in the sample, talked repeatedly about local and state institutions that were consistently cynical to the point of paranoia. This man was born in 1936 and would have been a professional with a young family on the eve of President Velasco's 12 year period of military rule. His responses have to be seen in the context of this upheaval and the attempts of the state to infiltrate and undermine Civil Society.

The Establishment Livelihoods were outside the intervention of CGPdA. The picture in the entrepreneurial group was more mixed with some households

getting assistance and others not. All the those in the excluded group were helped by CGPdA. CGPdA activities ranged from physical interventions in infrastructure and assets to building capacity for collective action and home-based entrepreneurial activities.

Outside the national or municipal state entities and the large, local development NGO were home-grown organisations focused on capacity building and business development but targeting certain vulnerable groups (young, deaf women, informal campesino communities). These organisations had aspects which straddled the market and civil society categories of the governance framework with their pseudo-profit-making character.

5.5 Livelihood Vulnerability: diversity and complexity in San Blas

As a reminder of what has been developed in this chapter, the livelihood groups can be characterised briefly as the **Establishment Livelihoods** group: the teacher-landlady (HH22); the comfortably-off young accountant with his teacher daughter (HH17); the upstanding retirees (HH24) with their ambiguous NGO sideline; and the verbose 'old-timer' with revolutionary tendencies (HH27). Their livelihoods were characterised by higher education (human capital), owner-occupancy (or low state rent) and access to urban labour markets. The range of activities was narrow, limited to public sector teachers and private sector accountants. This group was by-passed by the local NGO, Centro Guaman Poma de Ayala, and shared a residual expectation of the state, whether or not it had been met.

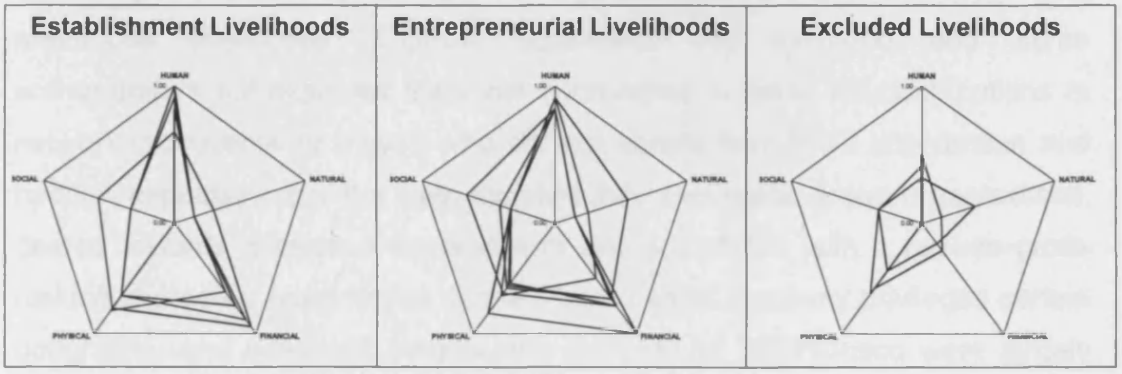
In the **Entrepreneurial Livelihoods** group, a much more diverse range of activities was introduced with the jeweller and committee president (HH28); the expansionist landlady renting ever more numerous rooms to foreigners (HH30); the multiple occupancy landlords and only farmers in the sample (HH23); the teachers with the internet café (HH18); the professional and market-seller couple with their elderly mother (HH19); and the street-food seller and her semi-professional children in (HH26). The themes of these livelihoods were more precarious financial assets and either developing human capital in the next generation or multiple adult professionals in the same household. One important physical asset was sufficient living space to rent or fill with capable relatives. Some households in this group had been beneficiaries of the CGPdA

upgrade project but those that had not had initiated their own local NGOs that concentrated not on poverty alleviation but enterprise development.

Those in the **Excluded Livelihood** category were the casual workers that were 'practically begging' (HH16); the moto-taxi driver working in Puerto Maldonado (HH29); and the elderly widow renting out space for another entrepreneur to run an internet café (HH25). These households faced insecure wages, low human or financial capital and, despite clocking up impressive periods as residents of San Blas, low social capital and exclusion from neighbourhood organisations. The neighbourhood committee had been established for just as long as these households, perhaps allowing very longstanding patterns of exclusion to become entrenched. Expectations of the state and the neighbourhood committee were low but they had all been beneficiaries of the CGPdA works to improve sanitation. The neighbourhood committee had been established for just as long as these households, perhaps allowing very longstanding patterns of exclusion to become entrenched.

Plotted as asset pentagons (Figure 36), the Establishment Livelihoods have assets concentrated in the human, physical and financial axes. The Entrepreneurial Livelihoods have, in some cases, slightly weaker human and financial capital but have a broader range of assets with social and natural capital balancing out the pentagon. The Excluded Livelihoods have a weaker all round asset base particularly in social, human and financial terms.

Figure 38 Disaggregated pentagon plots



There was a perception that location and economic activity were factors in the continuity and cost of water supply. First, there was a sense that certain users in the central tourist zones were prioritized but also that it was more expensive to supply water to the heritage sites where demand was high.

Tourism, population growth and excessive demand were blamed for forcing water restrictions on the population. The objections to the cost of water were bound up in the belief that the water meters were faulty and kept turning over even when pipes were running empty, the perception that household water consumption was low and the poor perceived quality of the water. In times of scarcity, inhabitants turned to public fountains or springs (el perro), rainwater harvesting, borrowing from neighbours or buying bottled water.

The links between households and the environment were limited, with low natural capital and geographic and psychological separation from the River Huatanay, waste disposal sites and water sources. Livelihoods were linked to tourism and the urban service sector but these strategies operated without the need to interlink within San Blas.

During the group meetings, older residents felt that San Blas should not be considered only the small area delimited by the Centro Guaman Poma de Ayala but as the much larger parish that it covered. There was a perception that different parts of the city were treated differently by the water company. In San Blas this was attributed to its central location, heritage value and tourism.

Only a handful of key people in the Establishment and Entrepreneurial Livelihood groups were involved in the neighbourhood committee. Residents anticipated using the private sector to improve their personal security. An external NGO, CGPdA, was active in upgrading network infrastructure and individual assets, building capacity for collective action and promoting home-based enterprise. CGPdA's help was targeted at the households with the most precarious livelihoods: CGPdA subsidised the excluded and some entrepreneurs but expected the most established to make full contributions to network improvements. Those who did not benefit from NGO intervention and had low expectations of the state founded their own home-grown organisations, geared towards enterprise development and sometimes with a pseudo-profit-making character. Apart from a sense that the water company privileged certain geographic and economic sectors, the activities of SEDACusco were largely mysterious.

Provincial intervention in San Blas focused on its being part of the 'historic centre'. The water provider was the provincial water company, SEDACusco, whose relationship with users was formalised through monthly water bills and a formal complaints procedure. CGPdA was involved in

sanitation and waste water connections with wide technical and social reach and worked through the neighbourhood committee and with individual householders. Community-based organisations had not been set up to tackle development of infrastructure with broad technical and social reach but focused instead on a particular cause or sector often straddling governance categories of civil society and market.

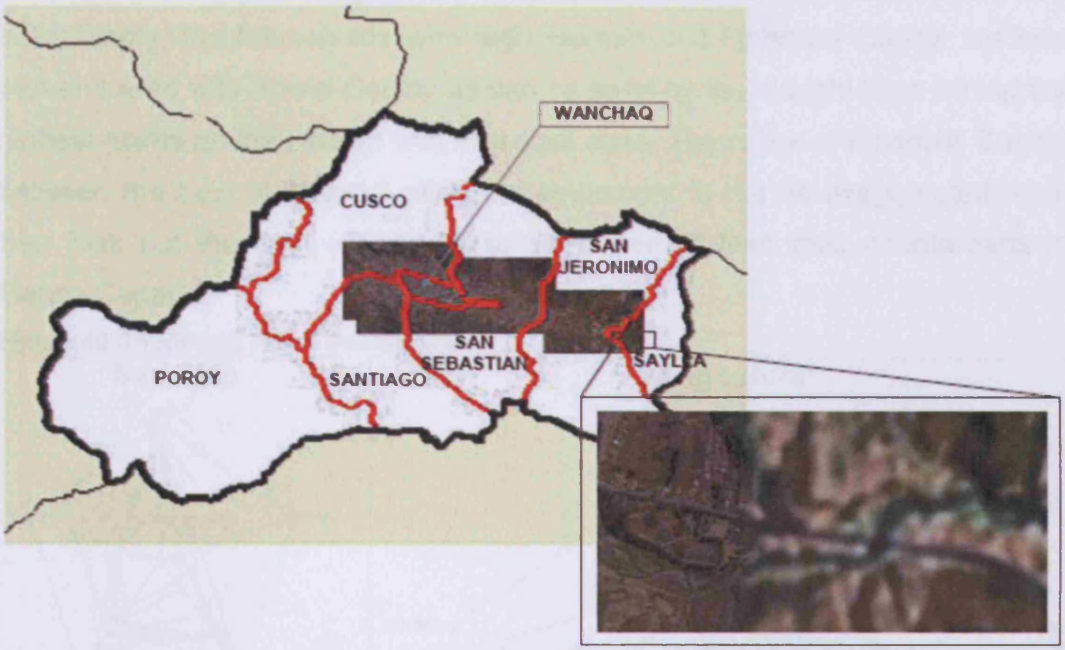
As a partial response to the research question, this chapter builds up a picture of the different livelihoods that co-exist in San Blas and compares the diversity and complexity of household assets that exist across a group that is ostensibly connected to the same water and sanitation system. Regardless of livelihood group, households were affected by insecurity, traffic congestion and competition with tourists for living space, peace and quiet and water resources.

While the impact of overflowing drains mapped closely to localised risk, vulnerability to flooding and heavy rainfall was linked to weak physical assets such as poor adobe construction and inadequate patio drainage. Limited financial capital meant that repairs and upgrades were a serious burden on household budgets. Poor storm water drainage was not entirely blind to livelihood but generally there was no escaping the combination of inadequate infrastructure, steep gradient and impermeable surfaces during the rains.

Chapter 6 Angostura: ‘agua dulce’

Our next case study takes us South East from the centre of Cusco, down the valley of the River Huatanay, to the district of Saylla. This district was founded on the 14th January 1942 under the presidency of Manuel Prado and lies about 14km away from the centre of Cusco city. Saylla District takes in peaks of up to 4,350m as well as swathes of the valley floor at 3,050m. It is here in the floodplain that we find Angostura, the first settlement in the district as we head away from Cusco.

Figure 39 Location of Angostura



This chapter examines the livelihoods of households in the Angostura settlement. Again, the chapter is structured according to the four analytical categories offered by the Sustainable Livelihoods framework. This time, though, the characterisation of livelihoods is themed by categories that have been labelled Urbane, Traditional and Diversified Livelihoods.

In the District of Saylla as a whole, 91% oh houses are of mud brick or adobe and 65% are owned outright by their occupants. Rented housing account for 15% and another 15% is provided by employers or other institutions (INEI 2005).

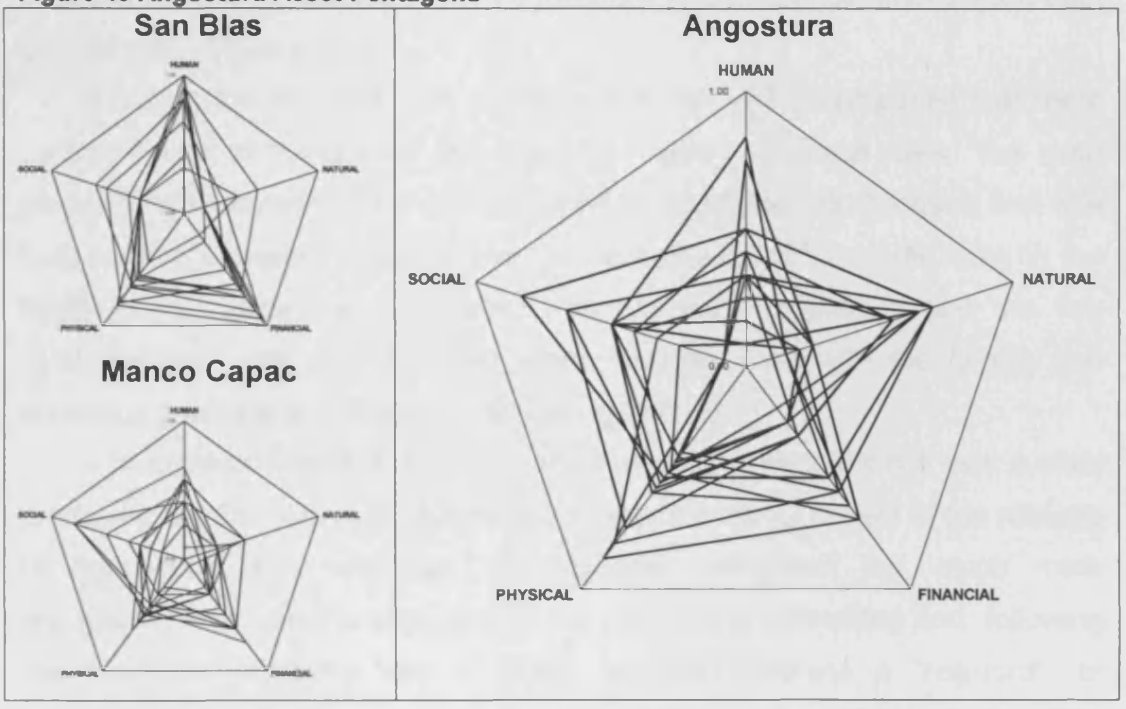
The heart of Saylla district sits on the site of three *ayllus*, or farming co-operatives, that date back at least five hundred years. Cutting the district neatly in half on the valley floor, is the River Huatanay, wending its way towards the

Amazon Basin, as well as the arterial Cusco-Urcos highway which connects the provincial capital to the high Andean plateau and eventually to Puno, Lake Titicaca and neighbouring Bolivia (Figure 37).

5.1 Angostura Pentagon Plots

The most obvious difference between Angostura's asset pentagon and those of San Blas and Manco Capac is that it is skewed towards Natural Capital with landownership and agriculture playing a more prominent role (Figure 38). Interestingly, the households with high Human and Financial Capital are less well endowed with Social Capital as can be seen by the straight lines joining the highest points on the Human and Financial axes. The range of Financial Capital between the best and worst off in the settlement is not as exaggerated as in San Blas but the best off appear to be better off than their counterparts in Manco Capac.

Figure 40 Angostura Asset Pentagons



6.1.1 *Urbane Livelihoods*: strong connections to the city's institutions

Of the households sampled in Angostura, only two have been classified as "urbane". We shall see that these households are different from each other but that they also stand out sufficiently in the case study group to merit attention. Worth noticing first of all, is the form of their asset pentagons: they both have strong human and financial capital. Household **1** appears better off in social

than in physical terms while Household **6** is much better off in physical than in social capital.

Looking first at Household **1**, this was a small family unit: parents in their forties and two primary school aged children. Both adults have completed a university education with the husband working as a professional for the municipality and the wife, a former paediatric nurse, running a grocery shop from their home. Their combined and stable monthly income is about 1,000 soles (£170). The family has lived in the barrio for 22 years and they own their house: a tiled, adobe building with cement floors. Clocking up more than twenty years in the settlement is, in part, what has enhanced the social capital measure shown on the pentagon but – and this cannot easily be quantified – it became clear on my regular visits that the matronly shop-owner was regularly called upon by other local parents to watch over the neighbourhood children while the adults worked (Households **2** and **3**). Natural capital appears low because there is no involvement in agriculture and household animals are kept only as pets or guard dogs.

During the interview with Household **6**, the wife emphasised that there was no "head of household" and that the couple took equal roles. The main similarity with Household **1** is the high level of education with husband and wife both holding university degrees and, of the five adult children still living in the family home, three had completed their university education and the two youngest were still enrolled. Two other relatives lived with the family, one university graduate and a primary school aged child.

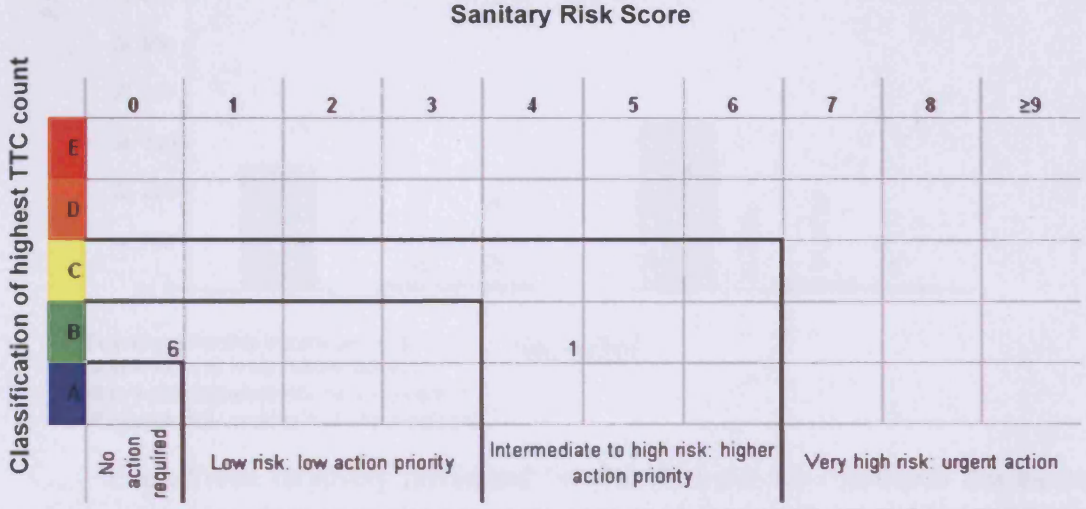
In common with Household **1**, the husband in Household **6** was a state employee but this time in a national government entity: a project of the Ministry of Agriculture. The wife was an economic consultant but, much more importantly, she was the president of the community committee and, following the municipal elections late in 2006, she had become a "regidora", or alderwoman, of the municipal authority. Again, the household income was stable and high at 3,000 soles (£515) per month and, although the family was a recent arrival in Angostura – they settled in 2000 – the house had been paid for outright. It was one of the few concrete block buildings in the settlement and had tiled floors and indoor taps and bathrooms. Despite the higher absolute income, the household still reared guinea pigs and chickens to eat and kept dogs and cats for security and as pets.

The following tables and figures give a graphical representation of the situation. Household 6 has a low sanitary risk score but thermotolerant coliforms showed up in samples from both households.

Table 21 Households and Taps in Urbane Group, Angostura

HH 1 'matronly figure' 4 people, 2 taps	HH 6 'president and extended family' 9 people, 3 taps
	

Figure 41 Sanitary risk score in Urbane Group, Angostura

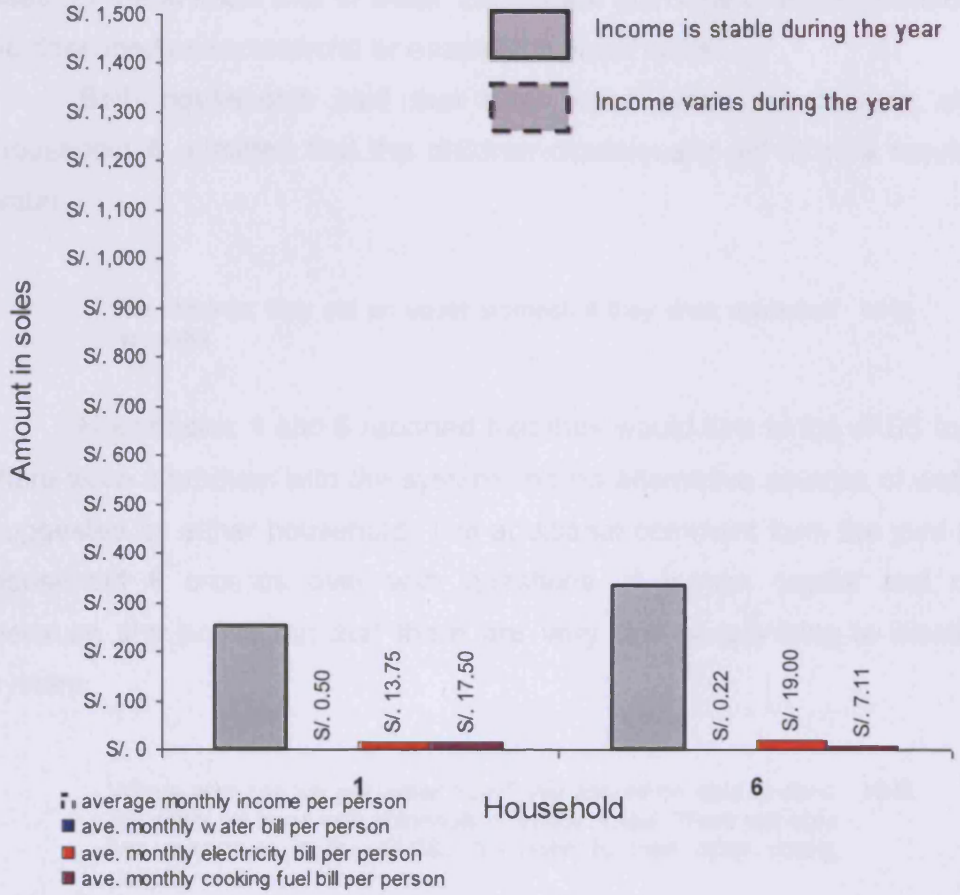


What distinguishes these households was that their formal sector employment provided stable and relatively high monthly incomes compared to others in the group. Reporting monthly income is also easier when salaries are based on formal contracts and paid on a monthly basis – rather than generated after every three month harvest as we shall see is the case for many households in Angostura.

These households also used gas for cooking and had high per capita electricity consumption which they both attributed to electric showers and, in the case of HH6, home computers. Households were not billed by volume and household water use estimates were unrealistically low given the service level

with HH1 estimated 10l/p/d and Household 6, which had multiple connections in the home including showers, kitchen sink, WCs, guessing 30l/p/d.

Figure 42 Monthly income levels and utility expenditure per person in Urbane Group, Angostura



Even these relatively privileged households did not command the same levels of income as the best off households in the establishment and entrepreneurial groupings in the San Blas sample, although incomes were stable. What is interesting is that the fixed, monthly water rate in the settlement does not even appear on the graphs of average bills per person – the cost is negligible and significantly less than the corresponding energy bills. In Household **1**, the electricity bill was regarded as high and the family explained that they had an electric water heater and an iron which is what pushed up the costs. In Household **6**, a similar explanation was given: the family had an electric water heater (used by many more inhabitants) and several computers.

These two households showed awareness of environmental issues in many of their responses but they do not have water meters and consequently have no idea of their overall water consumption[99].

Household **6** said that, in addition to domestic consumption, water was used for the animals and to water the garden but none of these activities could be described as commercial or essential to livelihoods.

Both households said that they boiled water for drinking and only Household **6** admitted that the children occasionally got ill as a result of the water:

> The children; they get an upset stomach if they drink untreated tap water HH6

Households **1** and **6** reported that they would turn to the JASS for help if there were a problem with the system and no alternative sources of water were suggested by either household. The additional comment from the joint head of household **6** crosses over with questions of human capital and capacity because she points out that there are very few people able to maintain the system:

> Where else can we get water from? We should be able to drink the water we have with chlorination, in our house. There are only two repairmen in the JASS. We need to train other young people. HH6

These livelihood profiles rely on stable, relatively high incomes from work in the public sector. Although both families reared small animals for home consumption, there was no direct link to agriculture.

[99] Even when I moved to a concept of bucketfuls rather than litres as a measure, the estimates were low.

6.1.2 *Traditional Livelihoods*: linked to the land

These households all owned land which they cultivated, sometimes alongside other formal and informal employment.

In Household **5**[100], the female head of household had not completed her primary education but the next generation was doing better with her son securing a tertiary technical qualification and daughter who had completed secondary education. The family said that they had always lived in Angostura but had been in their current house for 8 years. When it came to employment, the son was very vague describing himself as "independiente, tecnico". It became clear when we discussed security of income that he worked as a mechanic on buses.

> There is a lack of work in the rainy season, from December to March everything goes down. In the school term, there is demand for mechanics for the buses... HH5

He claimed his daily wage amounted to about 2,000 soles (£344) per month or 100 soles (£17) per day. My impression during the interview was that this was an exaggeration and in subsequent cross-checking it transpired that this would be three times what a university-educated school teacher would earn and does not tie up with comparable wages in the transport sector. This does raise an important point, though, that in this group, where employment is casual or based on the smallholding, it is harder to estimate cash income accurately.

Household **8** was demographically very similar to Household **5** with the head of household a single man of 45 with only a primary education who worked on the family's smallholding or *"chacra"*. He lived with two adult children and a daughter-in-law, all of whom had completed secondary school and a grandchild of 3 years old. The two women worked in the home and the other adult son worked as a driver earning a daily wage which he did not specify but from other interviews was probably between 10 and 20 soles (£1.70-£3.40) per day. The income from the smallholding was estimated at about 500 soles (£86) every three months. This works out at something between 366 and 566 soles (£63-£97) per month. This family had been in Angostura for 23 years.

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[100] Although the family group agreed that the head of household was the 42 year old mother and housewife, most of the responses came from her 25 year old son. The 17 year old daughter, the second member of the household employed in the home and mother of the youngest inhabitant, remained completely silent despite my best efforts to address everybody.

The remaining households in this group all relied exclusively on agricultural earnings. The head of household **11** proved extremely elusive despite many attempts to conduct an interview at different times and on different days of the week[101]. The family was large and extended including the head of household, his wife and 6 children (the youngest of which was at secondary school) and 16 grandchildren. Only the head of household had completed secondary education with his wife having only primary school level. Everyone, including the children, worked on the smallholding but they did not know the seasonal income in monetary terms. This family had been in Angostura for 20 years.

The female head of household **12** had not completed primary school and had three children ranging in age from 10 to 14. The main source of income was from a smallholding and she estimated her daily income as about 6 soles (£1) per day. She was also the only person in the group not to own her house outright: she was still paying instalments. This household had also been established in Angostura for 20 years.

Household **15** again relied on agricultural income with neither adult having completed secondary school and 3 children ranging in age from 7 to 17. Income in this case came from selling produce at the market every 3 months and it worked out at 200 soles (£34), equivalent to 60 to 70 soles (£10-£12) per month. This family had been in the barrio for 15 years, slightly less time than most of the households in this group.

The dependence of these households (HH8, HH11, HH12, HH15) on agricultural income also came out in their comments about fluctuations in earnings.

It all depends on the rain	HH8
May, July and August there is almost no harvest	HH11

Household **10** was a smaller family unit with two primary school aged children and parents who had not completed secondary education. Like Household **8**, the family had been in Angostura for 23 years. The head of household worked as a carpenter in a workshop in the home, earning around 20 soles (£3.40) per day, and his wife alternated between running a shop at the

[101] Twice during the day he was incoherently drunk!

front of the house, from which she estimated earnings of 50 soles (£8.60) per month, and working the family small-holding, yielding between 50 and 80 soles (£8.60-£13.70) every 3 months. This amounts to a monthly income of around 550 soles (£95). The school term seems to have an impact on household budgets but for this family, whose income comes partly from a shop and whose children are not yet in higher education, the effect is reversed: families have to spend more money in the shop on school equipment:

> January and February are the worst month because of the rain. When the kids don't have school [income] goes down. There is more in term time HH10

Household **14** was slightly different from the others in the group in that the head of household had a permanent contract with PeruRail – although there is a pattern here with employment in the transport sector. This family[102] also worked a smallholding and they estimated their monthly income at 630 soles (£108). This household was the most recent arrival in this group with only 13 years in the barrio. Although the parents only had a primary education, the eldest daughter was at university and this had an impact on the household budget which came out when I asked whether incomes varied at all:

> It changes: sometimes we don't have enough because the children are studying. The school term is worse because we have to pay about 15 soles (£2.60) per day on transport HH14

I have mentioned that the households in this group, with the exception of female-headed household HH**12**, owned their houses and had generally been living in Angostura for about 20 years. What they also had in common was ownership of land within the district but slightly further down the valley. All but Household **14** used water from the River Huatanay for irrigation. The crops included tall-growing maize (all except HH**10**) and animal fodder but also low-growing cabbage (HH**10**), potatoes (HH**11**, HH**15**), coriander (HH**11**), vegetables and carrots (HH**15**). Households **5** and **15** were also rearing chickens, sheep and guinea pigs to sell while everybody else reared chickens and other animals for domestic consumption: ducks (HH**10**), rabbits (HH**10**, HH**12**), guinea pigs (HH**11**, HH**14**, HH**15**) and cows (HH**11**).

[102] parents in their forties and four children between 5 and 19

The other feature of this livelihood package was the tendency to use firewood rather than bottled gas for cooking. Only Household 8 mentioned using gas occasionally. Everybody else gathered wood themselves from the forest or their smallholdings.

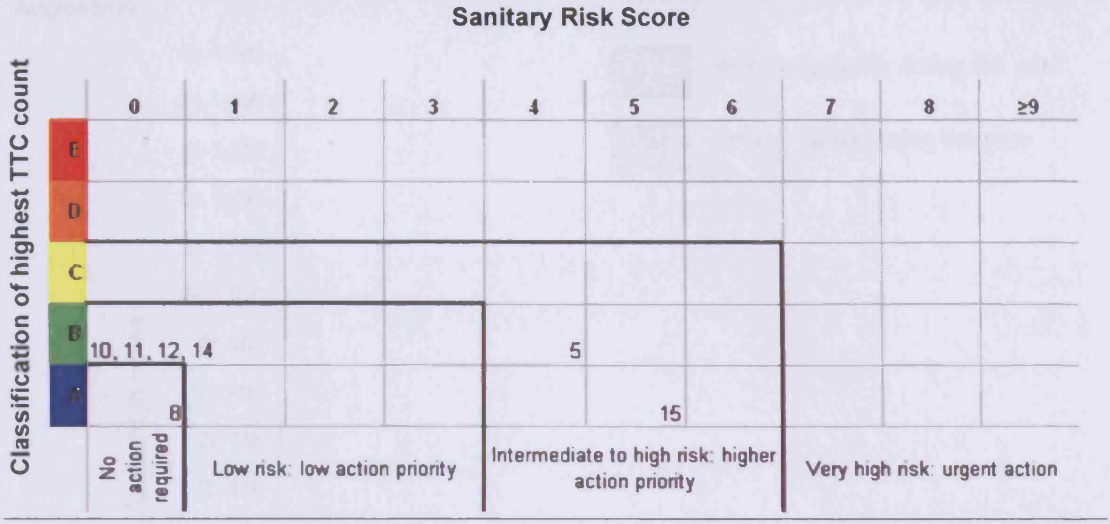
Lastly, all households in this group lived in buildings that were typical of the settlement: adobe with tiled roofs. Households **10**, **14** and **15**, these last two among the most recent arrivals, were the only families with sealed cement floors rather than earth indoors. Household **5**, on the left bank of the river, had no pavements but the other households on the right bank, did have pavements some of which were being newly built as I conducted the second round of water sampling.

With the exception of Households 5 and 15, sanitary risk scores in this group were lower. Only HH15 had a standpipe and all the other households had cement basins connected to the drainage system.

Table 22 Households and Taps in Traditional Group, Angostura

HH 5 'female farmer and driver son'	HH 8 'male farmer and driver'	HH 10 'farmer-carpenter-shop'	HH 11 'farmer and 16 grandchildren'	HH 12 'female farmer-young kids	HH 14 'farmers-PeruRail contract'	HH 15 'farmer-children 7 to 17'
5 people, 2 taps	5 people, 2 taps	4 people, 4 taps	13 people, 2 taps	4 people, 2 taps	6 people, 2 taps	5 people, 1 tap
						

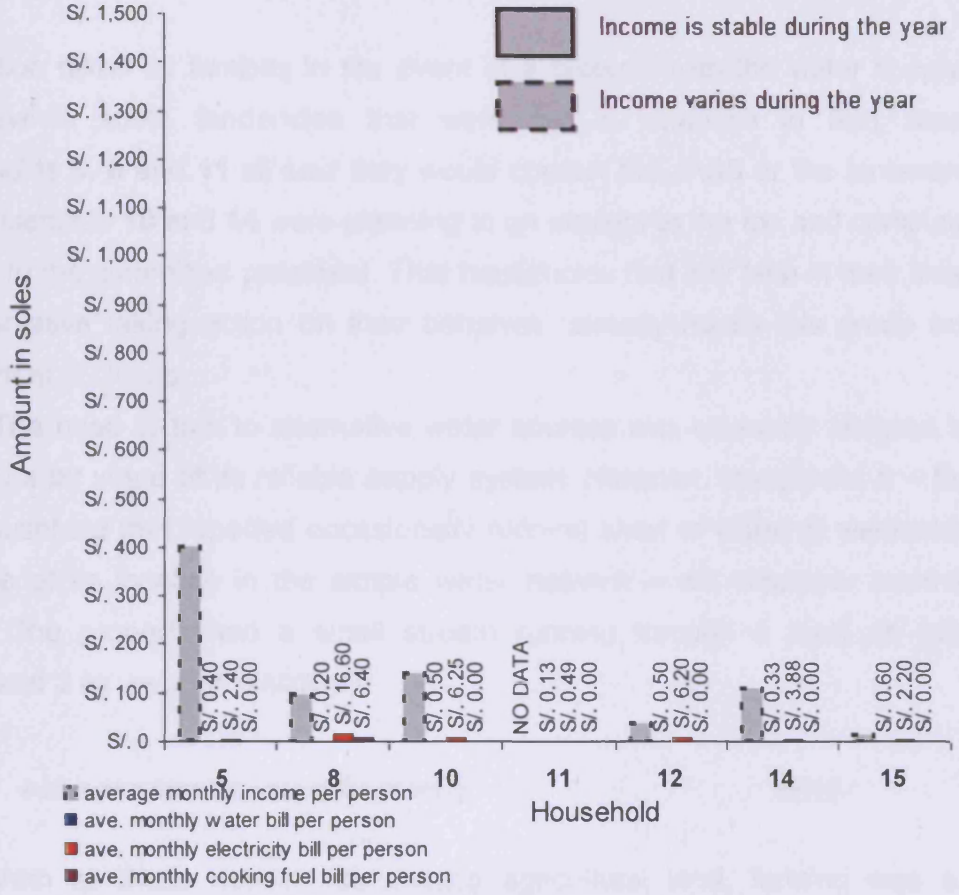
Figure 43 Sanitary risk score in Traditional Group, Angostura



Household 5 with the high income estimated by the bus mechanic son appears to have the highest, anomalous income in the group. Otherwise monthly incomes, where they could be estimated, were low and variable. Earnings depended on agricultural output only in HH11, 12 and 15. In HH5, 8 and 14 the supplementary income came from the transport sector while in HH10 the family had two home-based businesses to fall back on. Energy consumption per person was very low and most households used firewood rather than gas for cooking. Household estimates of water consumption ranged from less than 5l/p/d (HH8, 10 and 14) to less than 10 (HH5, 11 and 15) and were unrealistically low.

Household **5** appears to have a much higher income than others in this group but this is probably deceptive given the experience during the interview which I mention earlier in this section. Again water bills are negligible.

Figure 44 Monthly income levels and utility expenditure per person in Traditional Group, Angostura



Several families used water for household animals (HH**8**, HH**10**, HH**12** and HH**15**), plants (HH12) and making adobe or mud bricks (HH8, 15):

> [we do use water] for adobe but it's for the house. Nothing special — HH8

Although Household **15** was rearing animals to sell, water was not being used as part of any essential income generating activities.

In Angostura's traditional livelihoods group, opinions about water quality and behaviour are mixed. Most households admitted to drinking both untreated tap water and boiled water customarily in the home. While Households **5** and **15** only drank water direct from the tap. Household **15** had one of the worst installations of any of the sampled houses in Angostura. For a hint at its decrepit condition, see the photograph in Table 22:

[we drink water] directly from the tap. When we come in from the chacra, we are thirsty. HH15

The action taken by families in the event of a problem with the water supply, also reveals some tendencies that were not in evidence in San Blas. Households **5**, **8** and **11** all said they would contact the JASS or the fontanero but Households **10** and **14** were planning to go straight to the top and complain directly to the committee president. That households had any faith in their local representative taking action on their behalves, already marks this group out from others in Cusco.

The need to turn to alternative water sources was obviously reduced in Angostura by virtue of its reliable supply system. However, Household **5** – the only household that reported occasionally running short of water at weekends because of its location in the simple water network – did volunteer another option. The property had a small stream running through it (and on past Household **3** as we shall discover):

I use water from the stream for washing HH15

With all these households owning agricultural land, farming was an important livelihood activity, linked inevitably to the River Huatanay. Complementary activities included work in the transport sector and a home-based shop and carpentry workshop. Cash incomes were difficult for householders to estimate but they were seasonal and low.

6.1.3 *Diversified Livelihoods*: the go-betweens

This group has been labelled "diversified" but this does not necessarily imply a robust position of strength vis-à-vis livelihoods. By and large, these households are recent arrivals to the barrio and, even the couple that worked as "*chacreros*", or farmers, did not work their own land but worked on a casual basis for others. The jumble of household strategies arises out of necessity and a weak overall asset base. This is borne out by a look at the first household in this group, HH**2**, a couple with only a primary level education and three young children. The main source of income speaks volumes:

Sorting and crushing rubbish HH2

The head of household works at this full-time for a monthly wage of 300 soles (£52) and his wife does the same thing on a casual basis for about 50 soles (£8.60) per month and when asked about the variation in the household budget it was less about cash coming in as expenses going out:

> Yes it varies. In the school months it's terrible because of the fees, bus fares and note books — HH2

To make this cash income last, guinea pigs were being raised to sell and for their own consumption. This family had been living in Angostura for about 5 years – much less time than their counterparts in the previous section – and the house was owned by a parent.

This family's neighbours in Household **3** were in a curious situation, unique in the sample. Among the most recent arrivals with only 2 years in the settlement, this was a female-headed household with 5 children ranging in age from 3 to 16 years old. The mother had completed her secondary education but worked in a different province, in the rainforest town of Puerto Maldonado[103]. After repeated visits to the family and abortive attempts to sit down for an interview, I resorted to interviewing the 16 year old daughter since she was the acting head of household during their mother's absence (the mother was apparently at home but refused to come out for a chat). The daughter estimated the daily income as about 30 to 50 soles (£5-£8.60) just described her mother's employment as "a business".

> Sometimes there's a lot, sometimes there is nothing. At this time of year, there is practically nothing, it's the fiesta season — HH3

Neighbours described these children as "casi abandonada" – practically abandoned – and whatever the story, it was apparently an unusual set-up. Just from my visual assessment, it was clear that the house and yard were in a derelict condition and chickens that were scurrying about were just for the family's consumption.

In Household **4**, I encountered one of the most vociferous interviewees. This mother of three children under fourteen described herself as a housewife.

[103] this place came up in Chapter 4 as the regular place of work of **Household 29**

Although she had completed her secondary education and her husband had not, he was still the main breadwinner and worked as a bus driver for which he brought in about 15 soles (£2.50) per day. This varied, however, between 8 and 18 soles (£3) which meant a monthly income of between about 200 and 400 soles (£34-£69). This family also had guinea pigs scuttling about but only for their own domestic consumption. They had only been in the area for 8 months, making them the newest settlers. They did not own their home outright but were paying for it in instalments, which they were quick to emphasise were nearly paid off.

As in Household **7**, the head of household had a marginally lower education level than his spouse: she had completed primary school but he had not. This couple's livelihood was agricultural but unlike in the previous Traditional Livelihoods category, this family did not own their own land but worked at a combined piece-rate of between 3 and 10 soles (50p - £1.70) per day. What's more, they told me that:

> When it rains, we don't work HH7

This works out at an earning power during the harvests of about 280 soles (£48) per month spread amongst four people, two of whom were under 6, and falling to more or less nothing during the worst periods of the rainy season. Unsurprisingly, this income was supplemented by rearing a sheep, chickens, ducks and guinea pigs in their yard for their own consumption and to sell. This household too had only been in Angostura for a short time; 4 years.

The story in Household **9** was slightly more hopeful. The head of household with his incomplete secondary education worked as a labourer earning about 400 soles (£69) per month. His wife was based in the home and ran a grocery store from the premises. Three of their four children were at secondary school and the fifth was enrolled in a technical university.

> There are months when there is no work: January and February are more "casual" (eventual) HH9

The head of Household **13** had completed his secondary school education and worked as a taxi driver and artisan earning about 1000 soles (£171) per month. His wife commuted into the centre of Cusco to work as a

photocopier in a photocopying shop earning between 15 and 20 soles (£2.60-£3.40) per day. The combined monthly income was between 1300 and 1500 soles (£223-£258).

> Of course [income varies]! Each year it goes down, it varies. For example in January and February it drops because there is no tourism. There are no foreigners. From May onwards, there are [lots of foreigners]. HH13

The family reared chickens and pigs – they had a large, shared yard – but these animals were primarily for their own consumption.

These last two households, HH**9** and HH**13**, were both renting their homes. The shop owner-labourer couple had lived in Angostura for 8 years but only in the current house for a year. The taxi-photocopier couple had been in their rented house for 3 years but again had been in the barrio for a bit longer. These were also the only two households that did not have internal earth floors but more rugged cement surfaces.

Otherwise in terms of construction, this group was typical in having adobe buildings with tiled roofs, for the two rented homes and Household **7**, and corrugated iron for everyone else.

The household installations varied from leaking standpipes over earth patios with no drainage in HH2 to a concrete sink, taps and hoses in HH13. The water supply was not chlorinated and thermotolerant coliforms were found in several samples.

All householders had low and seasonal incomes that they often found difficult to calculate in cash terms. Household 13 with a non-agricultural livelihood and daily cash income gave the highest household income estimate. Others supplemented cash income with home-production of food. Water bills per person per month were very low and electricity consumption was lower than in the other case studies. Household estimates of their own water consumption were very low at less than 10l/p/d except in HH13 whose estimate was 12l/p/d.

Table 23 Households and Taps in Diversified Group, Angostura

HH 2 'waste sorters'	HH 3 'casi abandonada'	HH 4 'vociferous and bus driver'	HH 7 'tenant farmers'	HH 9 'shopowner-labourer'	HH 13 'taxi-photocopier'
5 people, 1 tap	6 people, 1 tap	5 people, 1 tap	4 people, 1 tap	6 people, 1 tap	4 people, 1 tap
					

Figure 45 Sanitary risk score in Diversified Group, Angostura

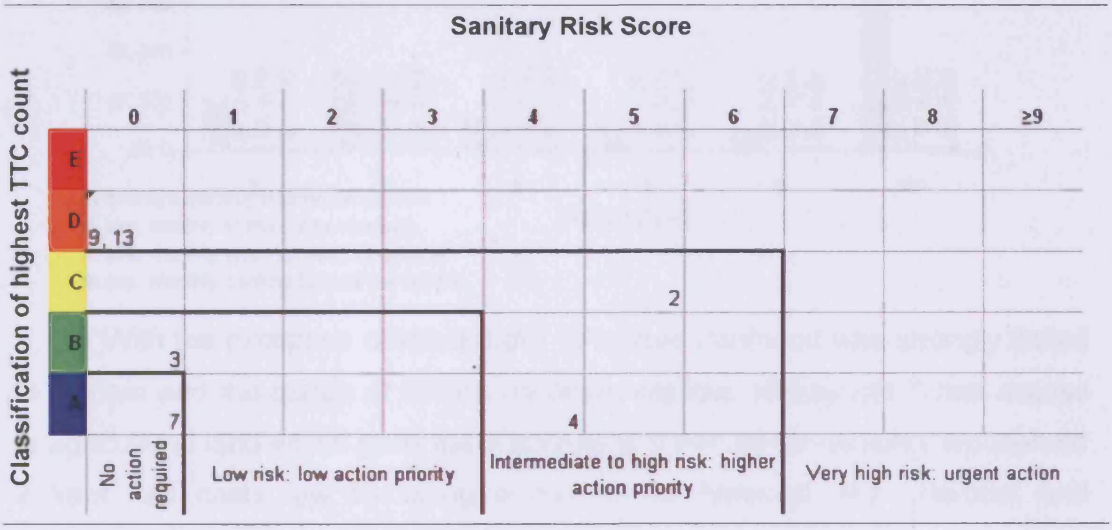
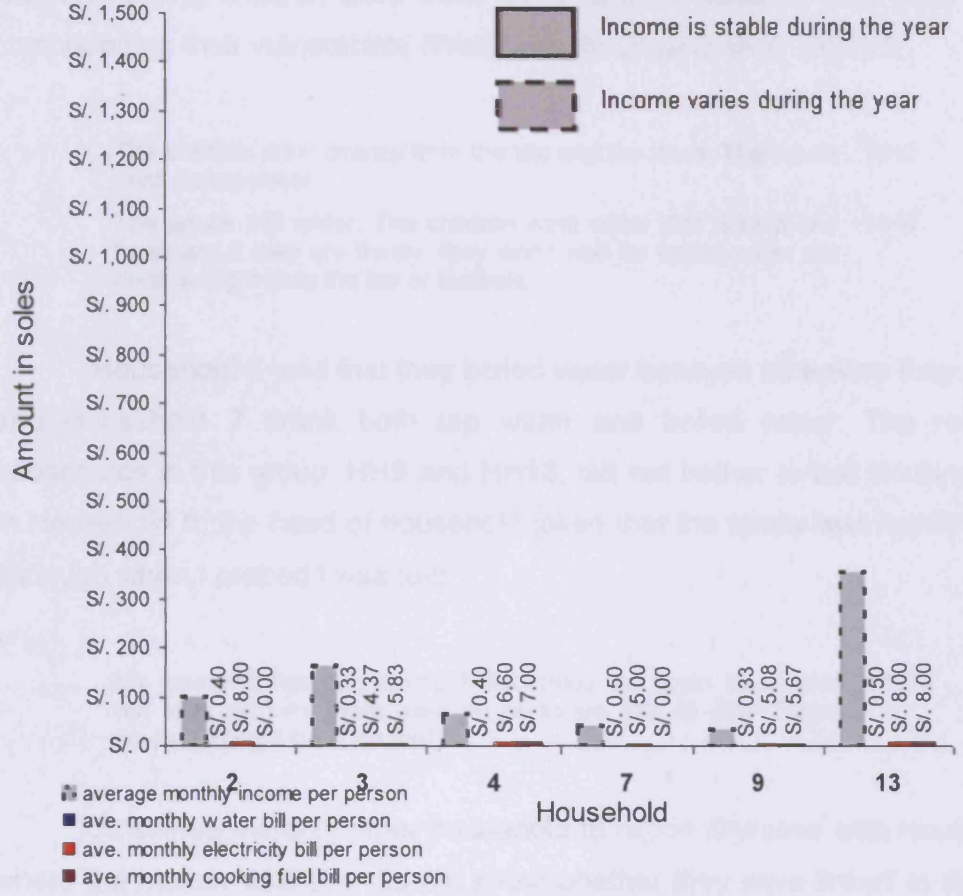


Figure 46 Monthly income levels and utility expenditure per person in Diversified Group, Angostura



With the exception of Household **13** whose livelihood was strongly linked to tourism and the centre of Cusco, incomes are low. Household **7** has access to agricultural land which gave them access to firewood for cooking. Household **2** kept fuel costs low by using a mixture of firewood and charcoal and Household **3** explained:

> Recently we've been using firewood because there's loads of it around. Sometimes we buy it, sometimes we get it from the hillside and sometimes my mother brings it from Puerto Maldonado HH13

Again in this group, it is difficult to make a case for any household income derived from the water supply. Households **7** and **13** use the supply when they tend their animals, which in the case of Household **7**, are sold on. Household **3** reported that the water supply was not used for anything other than occasionally watering plants. For making adobe, households mentioned using the "riachuelito" or trickle stream that ran past HH2, 3 and 4.

The result that emerged when we discussed treating water in the home was that young children were more likely to drink water directly from the tap compounding their vulnerability (World Health Organization 1997):1:

> The children drink directly from the tap and the drum. The adults drink boiled water — HH2
>
> The adults boil water. The children want water that is cold and fresh and if they are thirsty, they won't wait for boiled water but drink straight from the tap or buckets. — HH4

Household **3** said that they boiled water because otherwise they got sick and Household **7** drank both tap water and boiled water. The remaining households in this group, HH**9** and HH**13**, did not bother to boil drinking water. In Household **9**, the head of household joked that the family was hardly ever ill, although when I probed I was told:

> My youngest has had stomach infections but when the doctor ran tests on him, there were no parasites. We all drink "agua cruda" [straight from the tap] — HH9

Otherwise the only other household to report illnesses was Household **4** where the mother said she did not know whether they were linked to the water but the youngest children had had parasites and stomach pain.

In the face of brief stoppages, the strategy of Household **4**, whose location in the network sometimes meant that her taps ran dry, was to use her social capital and occasionally borrow water from her neighbour. With longer breaks in service, the picture was similar across households, with HH**2**, HH**13** and HH**4** saying that they would complain to the JASS:

> The neighbours lower down, give us water and if it is cut off, we simply go to the JASS; this zone doesn't have a service from SEDACusco — HH3
>
> We would have to complain to the president of the JASS. We'd go to his house. We need to work together so that there is water and the service is better — HH4

Household **3**'s response was interesting. They are recently arrivals to this outlying barrio and made a favourable comparison with the city's service from SEDACusco, emphasizing that it was *simple* to contact the provider in Angostura.

I was told, and observed, the use of streams for various activities from brick making to, on one occasion, an aromatic, communal coriander washing session. Like Household **8** in the previous section, Household **9** referred to the water source at Silkinchani. There seemed to be awareness that this water fell under the national government's remit rather than the local committee and indeed this is the case although it is the Ministry of Agriculture rather than a "Ministry of Water":

> If the tubes burst, the JASS fixes them, if not there'd be no water and we'd have to go and collect it from somewhere else. Opposite, from Silkinchani. If the quality was bad, we'd go to the ministry so that they'd sort it out HH9

This group did not rely on agriculture and landownership. Apart from the tenant family, all the households had diversified into other activities including a shop in the community, waste processing nearby, transport services and photocopying in the city centre. Despite this variety, cash incomes were low and householders supplemented earnings with their own production.

6.2 Vulnerability Context

Since 1994, Saylla district has marketed itself locally as both a spa town and an "ecological district" and, more recently, as the "district of ecology, gastronomy and sport" (Municipalidad de Saylla 2002):43. This reflects its popularity as a weekend destination for Cusqueños. Its gastronomic fame is derived from the local speciality "*chicharron*": dishes served with a glistening slab of pork crackling. The *chicharron* restaurants line the main road through the district capital Saylla and the sector was reportedly worth 708,000 soles (£122,000) in 2001 (Municipalidad de Saylla 2002). This hints at a broader picture of livelihoods that are based on agriculture with 19.3% of the economically active involved directly in arable farming and livestock production and the remaining 80.7% in complementary activities, of which chicharron is but one.

Livestock farming in the area remains traditional but for arable activity, with its biannual harvest, the farming tends to be intensive and mechanised with maize, fodder and vegetables the most profitable crops. Of concern to this study is that an estimated 80% of agricultural land is irrigated using water from the

River Huatanay. This and other pressures on agriculture are recognised in the area's integrated development plan:

> In the district of Saylla, agricultural and livestock production is stagnating because the population is unable to invest in new technologies and because of the use of contaminated water for irrigation and the permanent loss of land available for cultivation caused by urban growth.
>
> (Municipalidad de Saylla 2002):64

These remarks on the quality of irrigation water are stark when we see Angostura's position relative to Cusco's main waste water treatment plant at San Jeronimo in Figure 51: the settlement is just a meander away from the plant's discharge. The state of agriculture in the Saylla has also to be seen in relation to the rest of the River Huatanay's catchment. SEDACusco's annual report on the performance of their treatment plant and the River Huatanay (SedaCusco 2005) makes alarming reading. It describes the river basin as comprising two parts: an upper section that includes about 90% of the urban area and a lower section which is predominantly agricultural. According to this document, 90% of the river's pollution comes from the urban zone in the form of untreated waste water, solid waste, detergents, hydrocarbons and oils.

> The sewage effluent from the city of Cusco are treated by a conventional treatment plant which is currently functioning relatively well with primary and secondary treatment; domestic effluents receive a significant load from hospital sewage, car-washing, lubricants, light industry and a variety of workshops; the industrial wastes come mainly from the brewery and Coca-Cola, as well as the abattoirs in San Jeronimo, Santiago and K'ayra, these last two being the ones that cause a significant increase in the biological oxygen demand of the river because their effluents go straight into the river without a pre-treatment to remove all types of waste direct from the slaughtering of livestock (blood, entrails/innards)
>
> (SedaCusco 2005)

This is all underlined with reference to Peru's own national water quality standards, detailed in the document *Decreto Supremo 007-83-SA: Re*. This classifies waterways according to their use. Classification III is of interest here since it deals with "water for the irrigation of vegetables consumed raw and drinking water for animals" (Government of Peru 1983):1. A closer look at Figures 45 to 48 show four of the typical indicators recorded by SEDACusco in 2005 at various points descending the Huatanay valley shown below their recommended limits is alarming. At Angostura just beyond the treatment plant, the annual averages exceed by orders of magnitude the limits:

Figure 47 Total coliforms

Total Coliforms:	**5,000**

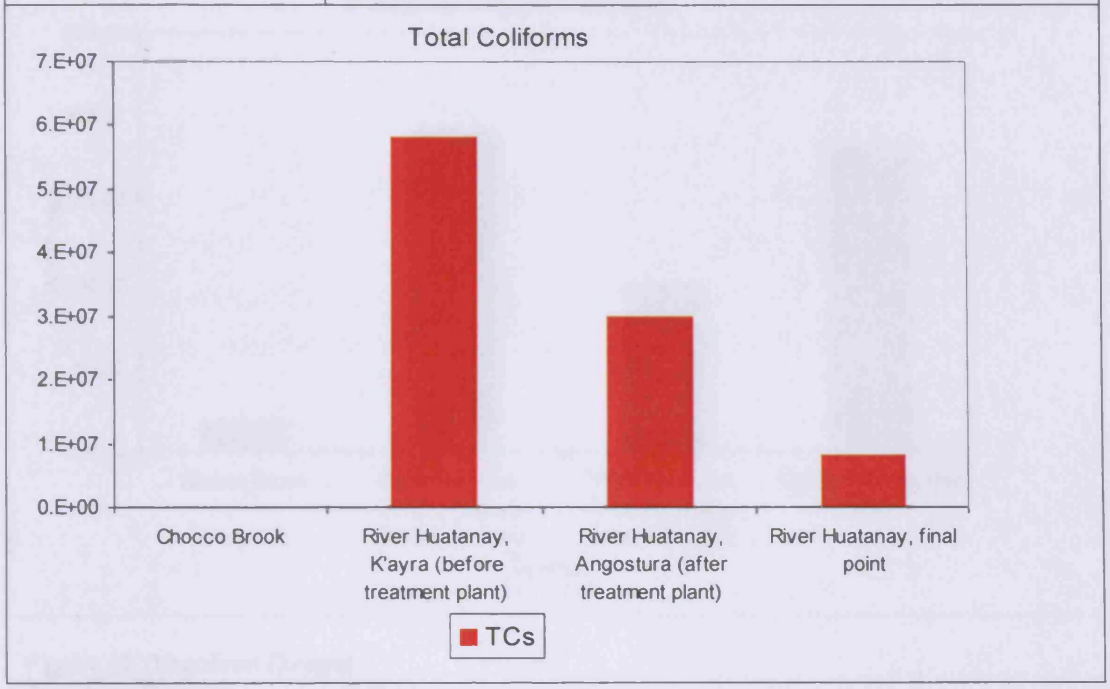


Figure 48 Thermotolerant coliforms

Thermotolerant Coliforms:	**1,000**

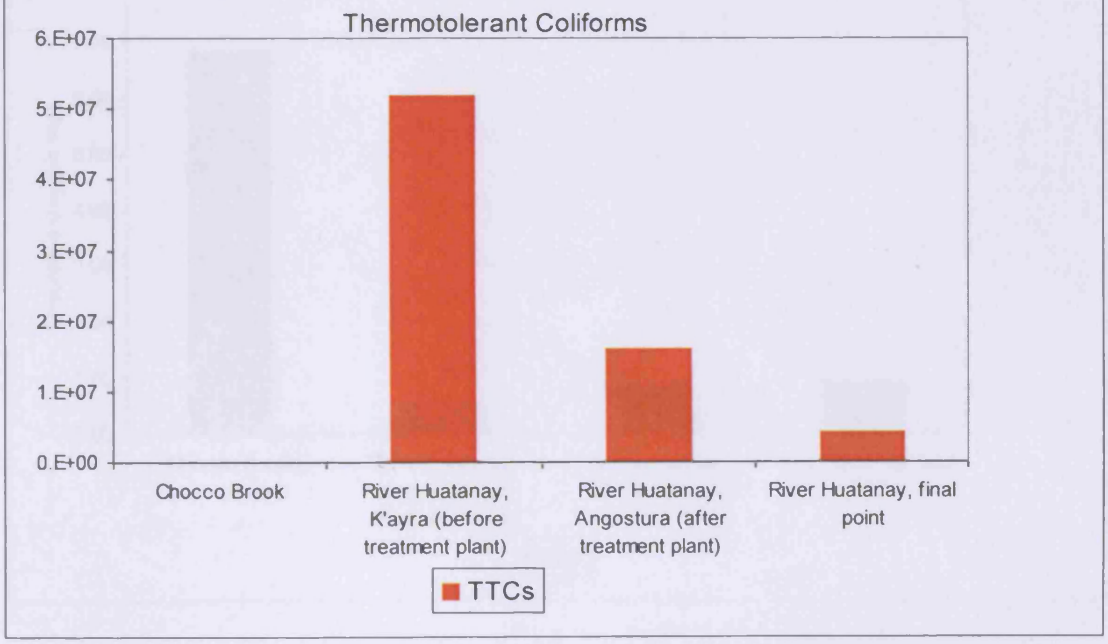


Figure 49 Biological Oxygen Demand

Biological Oxygen Demand(5):	**10 mg/l**

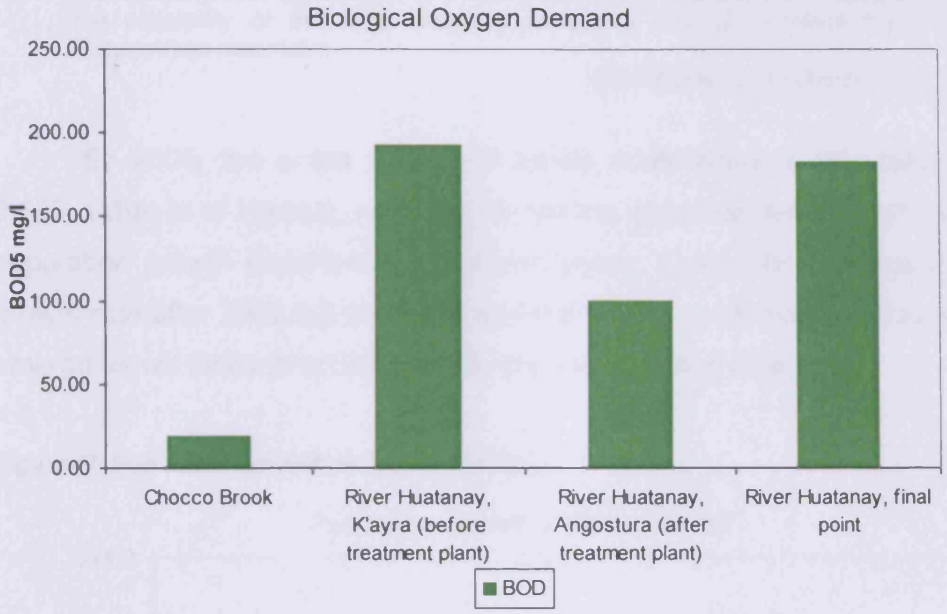
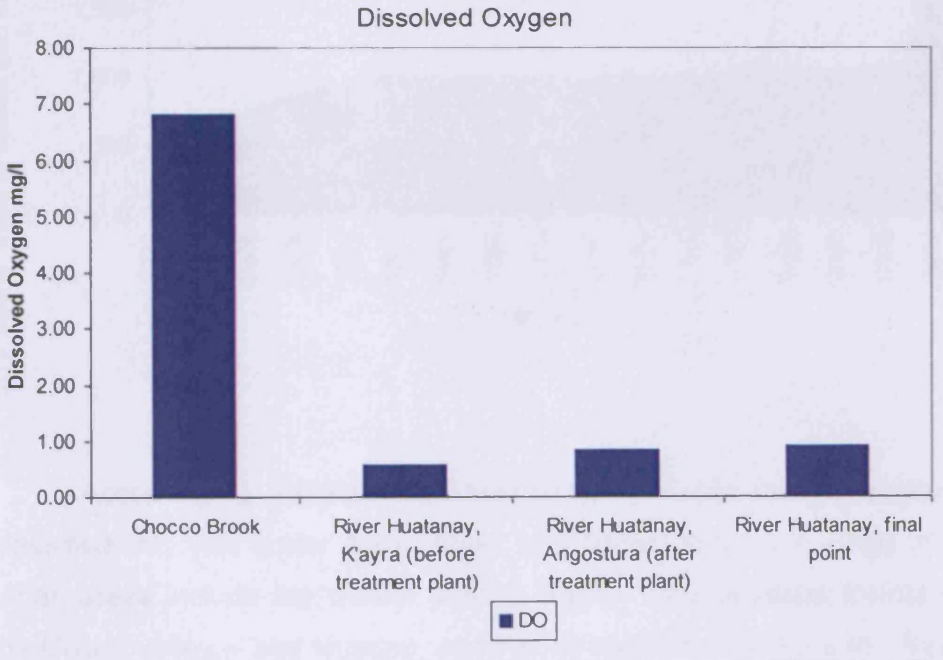


Figure 50 Dissolved Oxygen

Dissolved Oxygen:	**3 mg/l**

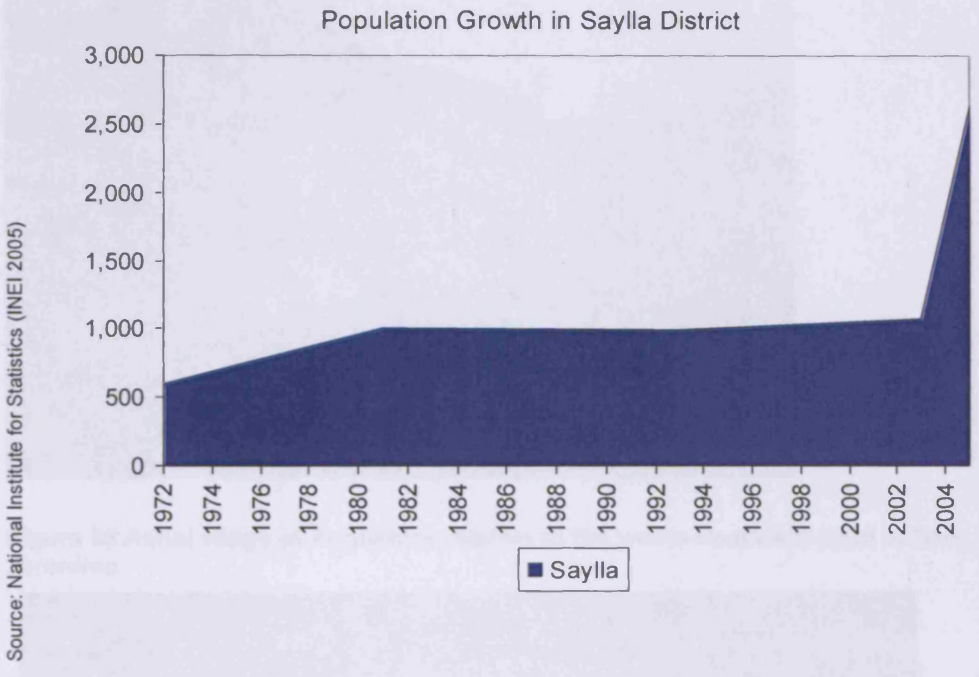


In terms of natural hazards, the flood plain is marshy and prone to flooding during the rainy season. A landslide risk has also been identified along the steep sides of the valley – a risk which has been increased by deforestation.

> The inappropriate occupation of ravines and the banks of the River Huatanay with housing and agriculture, is a latent risk which exposes the inhabitants to the possibility of the river breaking its banks and of landslips from the Hatunwayqo mountain.
>
> (Municipalidad de Saylla 2002):79

By 2005, the entire district of Saylla could boast a population of only 2,635. What is of interest, perhaps, is not the absolute number but the rate of population growth experienced in recent years. Figure 49 shows a change in growth rate after 2002 but there are several factors contributing to this which will emerge as we focus in on Angostura, the second case study site.

Figure 51 Population growth in Saylla District



According to the National Institute of Statistics the population can be classified into just under 80% urban and about 20% rural (INEI 2005). The urban areas include the district capital, Saylla – the smallest district capital in the Cusco valley – and Huasao, another consolidated settlement. New growth areas tend to be along the Cusco-Urcos highway and these are joining up into what is turning into a continuous urban settlement. There remain, though, "annexes" and campesino communities which are more ambiguous in their character.

Angostura is one of these annexes. It was formed when the land was transferred to the current association in 1980 by the campesina community that had owned it (Angostura President Interview 2006). It is now a settlement of around a hundred and fifty families, of which about 10% are renting, and is described by a recent local publication as being one of:

> [Angostura is amongst] the smallest rural population centres that are seeing a process of consolidation in the district of Saylla.
>
> (Municipalidad de Saylla 2002):54

Angostura is also counted among the 72.75% of the district's population with access to basic services such as water, drainage and electricity.

Figure 52 Angostura on the right bank of the River Huatanay

Figure 53 Aerial image of Angostura relative to the waste treatment plant at San Jeronimo

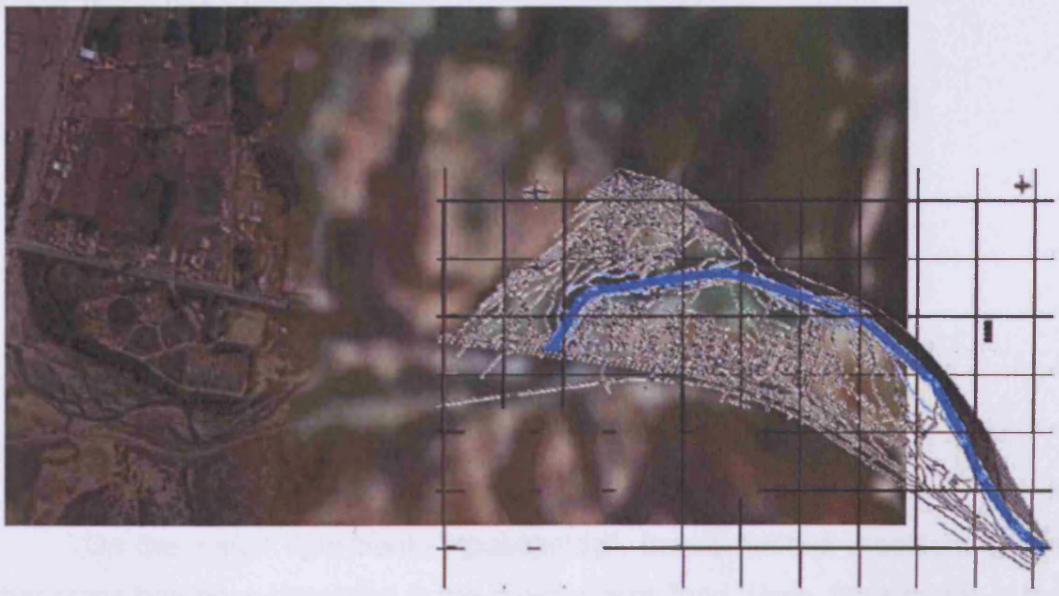
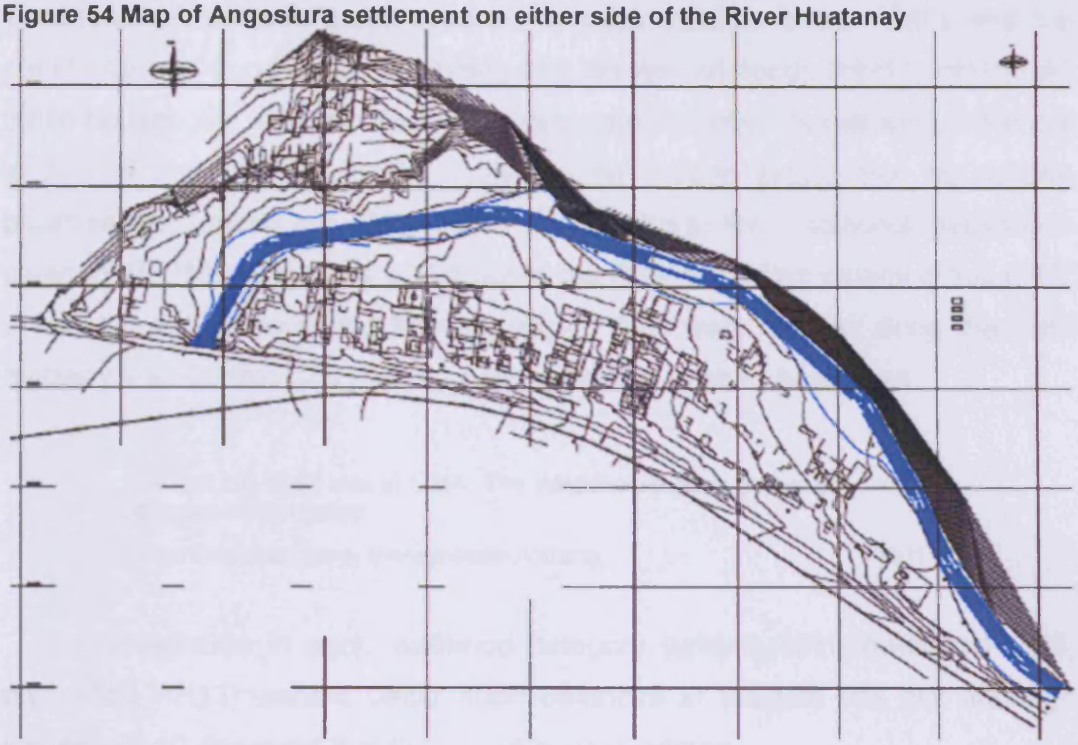


Figure 54 Map of Angostura settlement on either side of the River Huatanay



6.2.1 Natural Hazards

The main hazard identified in Angostura was the annual flooding. The interviews confirmed that the flooding tended to affect households on the left bank of the river (outside the meander) more than the right.

Of those on the left bank, Household 1 in the urbane group summed up the impact with Households 3 and 4 in the diversified category mentioning other actors in the flood response:

> [the main natural hazard is] flooding of the river which affects the water supply, the electricity, the telephone line and our properties. It comes right up to here [level of the patio]. The last one was on 6th March 2006 but they happen every year between January and March. The municipality give us sand bags, stones and machinery to protect the drainage system and clear up the river. — HH1
>
> [The committee] calls meetings, for example, to do the gabion wall in faenas — HH3
>
> The wall has been built by the district council in Saylla and the Municipality of San Jeronimo. The Civil Defence helps, we have faenas and they lend us a tractor — HH4

On the 'safer' right bank, Household 6, the committee president added that crops had been damaged in the most recent flood. Here, households in the

Traditional Livelihoods group reported a major incident in the 1990s and the construction of flood defences (HH8) and the annual floods (HH11, HH15). All these households said that the community came together to bail each other out in *faenas* and claimed, unlike those in the urbane group, that no outside organisations helped out. Three more households in the Traditional Livelihoods category (HH**10**, **12** and **14**) and three in the Diversified Livelihoods group (HH7, 9 and 13) did not raise the flooding issue. They were located along the main highway – as far from the river as it was possible to be in Angostura.

The last big flood was in 1994. The neighbours get together but no organisation helps	HH2
Since I've been here, there's been nothing.	HH13

Households in each livelihood category (urbane HH1, traditional HH5, diversified HH13) wanted better flood defences to mitigate this risk although Household 10 observed that this would be challenging:

A channel so that the river can be contained	HH1
The other side is worse but there's no way to control the river	HH10

In Household **2**, I thought at first that the adobe step into the kitchen was a flood defence but when I asked, I was told through laughter that it was actually to stop the guinea pigs escaping!

Figure 55 Road bridge joining two sides of the Angostura settlement across the River Huatanay in the dry season

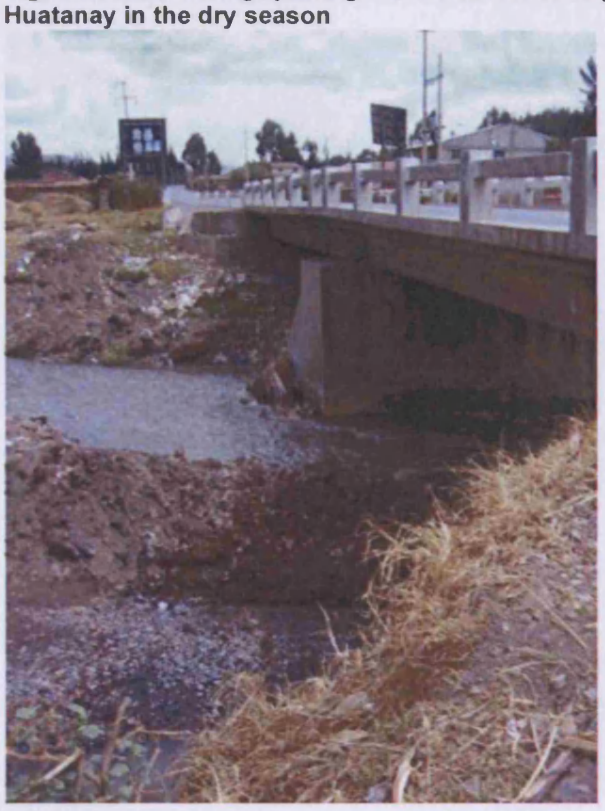


Figure 56 Road bridge during the wet season

6.3 Infrastructure and Services

In terms of urban services, the district capital has a health post, a police post, primary and secondary schools and a weekly waste collection, although this is strictly confined to the consolidated, central settlement of Saylla.

Incidentally, the collected waste is transferred to an unregulated dump on the banks of the river from where it gradually seeps and tumbles into the torrent.

> Saylla is a district with high levels of environmental pollution mainly because of the population of the city of Cusco and its surrounding districts; but also because of and inadequate system of solid waste collection and disposal in the district.
>
> (Municipalidad de Saylla 2002):64

> Run-off is drained through the sewerage system, leading to blockages with mud and sand. This then causes the backflow of waste water into people's homes.
>
> (Municipalidad de Saylla 2002):78

> One of the most significant health problems, especially among children, is linked to the proliferation of sources of infection caused by the pollution of the River Huatanay and the build up of solid waste in different parts of the district.
>
> (Municipalidad de Saylla 2002):78

Poor local education services mean that people choose better facilities in the city of Cusco – the claim of this document is that this wears away local identity and renders the young people indifferent to the development of the valley. The lack of telecommunication infrastructure also impacts on education facilities:

> The telephone service is inadequate and only has minimal coverage. In addition, it is impossible to access the internet despite its close proximity to the city of Cusco, 14.5 km away.
>
> (Municipalidad de Saylla 2002):79

6.3.1 Solid Waste and the River

In Angostura, the shocking revelation is that there is no waste collection service. Across livelihood groups (urbane HH**1**, HH**6**, traditional HH **8**, **11**, **12**, **14** and **15,** diversified HH**7, 9** and **13**), householders were forced to dumped their waste into the river. Even those adopting strategies to burn, bury or compost parts of their waste (urbane HH1, traditional HH5 and HH10, diversified HH2, 3 and 4) admitted that most of it ended up in the river. Even for the well-placed committee president, there is little that can be done. Indeed, her attention to detail with respect to organic waste contrasted with the environmentally hazardous disposal of everything else highlights the futility of individual action:

Well, the treatment of solid waste is like this: we separate organics for use as compost for plants and the inorganic component is thrown onto the river bank	HH6
We take it to the chacra to burn it	HH10
I put some in the garden [the organic things] and the rest in the river. It ends up in the river.	HH2
I put it in the river. I don't know where it goes... the river. Some people collect bottles but only bottles. I want rubbish trucks!	HH3
I burn it on the patio. The soil [organics] I leave in the field. It ends up in the river. The cans, the recyclables go into the river because there is no rubbish truck. Everything goes into the river: a dog dies, it goes into the river. We are the only ones affected by our behaviour. There are mosquitoes and it's dangerous for our children. My children have had hepatitis and the doctors said it was from eating something dirty - faecal - fruit or vegetables.	HH4

Again across all households, regardless of livelihood group, the main culprit in all this is the municipality. The community wanted a service and most households reported making repeated requests for collections from Saylla District. As Household 13 points out, however, the problem is bigger than Angostura:

The municipality has forgotten about us. There used to be a tractor but it stopped coming	HH8
But what's the municipality going to do? When are they going to clean up the river? But they don't do anything or send anyone)	HH4
It's because of the mayor...we've asked...but the mayor's office doesn't know where it can dispose of the rubbish either!	HH13

6.3.2 Waste water and the River

Angostura's relationship with the river has several dimensions: first there is the stress of contamination from upriver identified in vulnerability context; next is the flooding shock; and closer to home the stress of their own contamination through discharge of their own waste water and dumping of solid waste.

Domestic waste water connections have gradually been installed over the last 5 years by the water committee with the support of the Centro Guaman Poma de Ayala. These convey waste water to two small primary treatment plants. Prior to this both urbane households had piped connections that discharged directly into the river (HH1, HH6). By contrast the Traditional (HH**5**, **10**, **12**, **14** and **15**) and Diversified Livelihood (HH2, HH7) groups reported going outside" or using a "dry toilet" or latrine before the service was installed.

We've had a connection for 5 years. The JASS installed it. The waste water goes to the treatment plant and then the river.	HH2
3 years ago Guaman Poma connected us and the work was done by a faena. The waste goes down there to that thing like a reservoir	HH7

Urbane Households **1** and **6** were distinctly upbeat about the environmental benefits of this system. Households **5** and **14** in the Traditional Livelihoods group were aware of the treatment system but commented that the maintenance left something to be desired:

It's good because we have treatment and we are not polluting the river. It has been in the last two years that the families have got together in cleaning teams and they pay an extra sol each month. This contribution is to pay the "fontanero" [maintenance man][104]	HH6
It's improved because sewage goes to the plant instead of straight into the river. It works well but when the river overflows during the rainy season, it can scour away the pipes.	HH1
Yes [the plant] works well. Before we had no WC but it would be better if they took better care of the plant. It's not clean and pigs graze there. The river: it infects the children, the sewage plant [in San Jeronimo] also smells really bad when it rains	HH14

By contrast, households in the Diversified Livelihoods group ((HH3, 4 and 13) did not mention the new treatment plants and were still worried about environmental pollution. Household 4 pointed out that she still felt the effects of other settlements that did not have a system:

I don't know about the connection but waste goes into the river. Everything goes into the river. It's polluted	HH13
Other settlements higher up [the mountain] don't have sewerage. There are no connections. They go outside and this attracts flies. Rubbish also washes down. I try to sort it out as much as possible, burning it and so on but we should have more workshops to raise awareness for the well-being of our kids. They think "I'm ok so it doesn't matter about anyone else!"	HH4

The effectiveness of local waste water treatment was influenced by the flooding hazard and nearby settlements without any services whose waste washed into Angostura.

[104] Payment of the "fontanero" is a point which we will look at again in Chpater 7's analysis of system configuration.

6.3.3 Energy

According to the 2005 census, the dominant household energy for cooking in Saylla District is firewood with gas a distant second (INEI 2005).

Urbane Households **1** and **6** both said that they would call the electricity company in the event of a power cut[105]. Most families with Traditional Livelihoods[106] said that they just sit tight and wait when the power goes off. Household **10**, the only household in the traditional group with two home-based livelihoods – the grocery store and carpentry workshop – in addition to their small-holding said that power cuts were a daily occurrence. In the Diversified Livelihoods group, the reaction to power failures was resigned with only Household **9** prepared to complain to the provider. HH9 was running a shop from their rented premises and so had an interest in lighting and power for their home-based livelihood activities.

Household **5**, in the traditional group, and Household **4** in the diversified group, pointed out that the electricity company office was in Urcos – a ninety minute and 3 soles (50p) bus journey out of town – and that it would take the company a week to fix anything:

Electrosur have an office but it's a bureaucracy	HH5
We don't complain because it's too far away. When you complain at the office you are told to wait. Either nobody is there or the person you need is busy... There is no point going. They don't give any information to people and if they know you are from a "pueblo joven" or if you don't wear a suit, they are rude. Why go if they're just going to be rude? They are arrogant. The more educated, the more despotic! Professionals don't explain anything to people. We are the worst affected but speak up the least. The company says the electricity is "a favour" because we are not organised. There is no public registration [of our settlement], we don't have land titles. When they make the maps, our houses are not on them.	HH4

When Household **4** lets rip about the face of Peruvian bureaucracy, even its fury, it captures such a familiar refrain for anyone who has lived in Peru about the relationship between the excluded and the included. The reference to people from the "pueblos jovenes", the new towns described in Chapter 3,

[105] HH1 estimated 2 to 3 power cuts a year for up to 12 hours, attributing them to electrical storms in the rainy season, HH6 estimated 6/year for a couple of hours

[106] Households **5**, **8**, **10**, **14** and **15** all experienced an estimated 3 to 5 power cuts a year lasting from half an hour (only HH 8 and 15) to all day or all night

introduces what, in this interviewees view, are tangible impacts on access to services[107].

Again Household **15** differed slightly from other households in that their reaction was to sort the system out themselves.

I'd turn off the valve and fix the pipe	HH15

6.3.4 Policing, transport and recreation

The stress generated by crime was much less significant here than in San Blas. Location rather than livelihood group was the determinant, however, with the households facing the main road more concerned than those set back from the road or on the opposite bank of the river. Household 13 mentioned that they'd had a child's bike stolen: this is a far cry from the street robbery and violence in the centre of Cusco. As in San Blas, the response was to contract guards rather than rely on the police service:

The settlement is peaceful. Pets get lost sometimes... we are discussing the presence of security guards at the moment because some people have asked for night-watchmen	HH6
Each house pays 1 sol per month for the security guard	HH14
I have been burgled but the police didn't do anything! My child's bike was stolen but without a receipt, they can't press charges	HH13

Other concerns were related to transport including poor roads, the dangerous road bridge connecting the right and left banks and the need for a proper bus shelter (traditional HH4, HH5 and HH8 and diversified HH2, HH4). Several households also mentioned the lack of community and recreational space[108]. Household 15 wanted a closer health post and Household 12 said that there was no electrification to small-holdings.

Improved streets and a pedestrian bridge – the road crossing is dangerous. There is no street lighting so at night the main road in is dark. It's slippery and muddy.	HH4
Recreation facilities for the children and young people; there is nowhere for the kids to play football. There's a field at the school but the school closes. The women play too. In the kindergarten, the parents play. There are green spaces but they need to be looked after.	HH9

[107] Street lighting was also mentioned.

[108] Households wanted a community centre or church (Traditional: HH5, HH8, HH15, Diversified: HH7) a market (Traditional: HH5, HH15) a park or pitch (Traditional: HH5, Diversified: HH9)

Informally, one householder also commented on household finances.

> No one has a bank account, people need savings especially in case of illness, everybody should put some money aside but nobody does. To raise cash in an emergency people sell products at market, sell off land and sell vehicles, that's the only way. HH9

> According to the president, the community is 80% towards getting registered. The land was sold off 10-15 years ago but not having public registration means that the bank won't lend the families money so even though they need to improve their houses, they can't. HH4

While most of the residents interviewed named physical assets that they would like to see changed, the president of the settlement committee and one of the most recent arrivals talked about changing the people!

> The people: the human factor, capacity building. There is ignorance and a lack of information and basic needs like education, healthcare, housing and income from employment and projects. Development is not possible without working with people on ecological, gender and identity issues HH1

6.3.5 Water

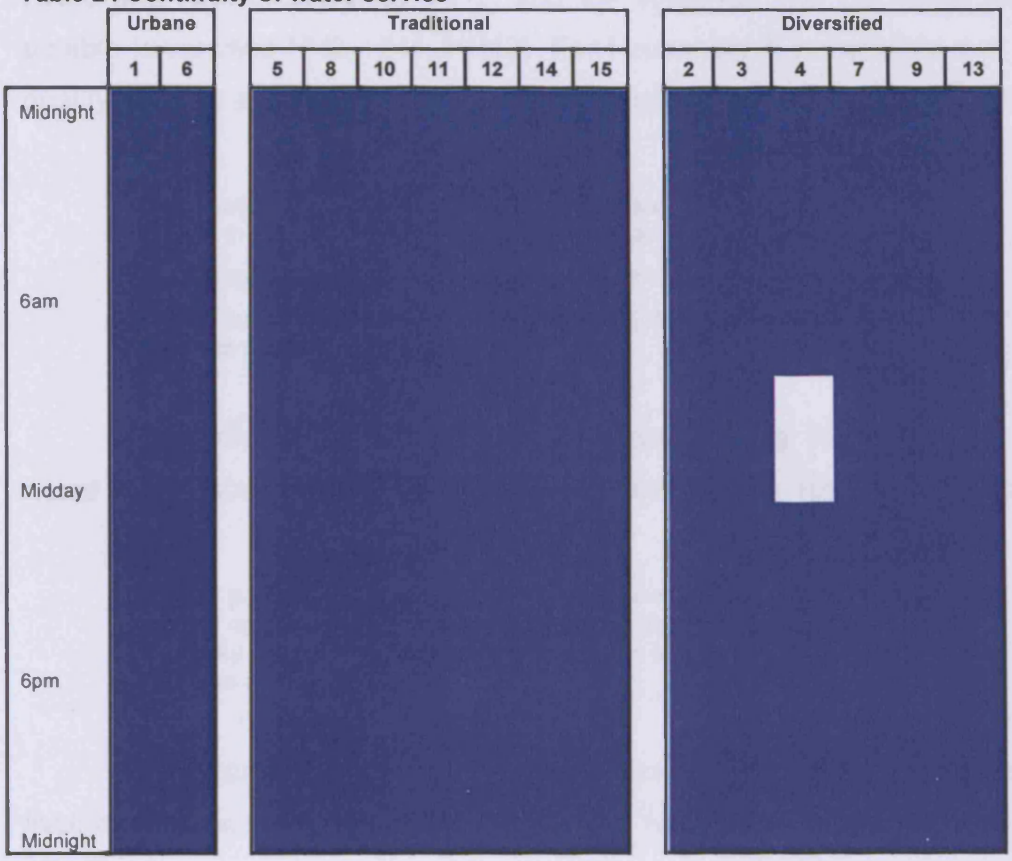
Looking across the District of Saylla, the census data suggests that Saylla has increased water and sanitation services dramatically over the last decade. By 2005 the percentage of households with a water connection in their demise had risen from 47% in 1993 to 73%. The percentage of households with a waste water connection in their demise increased from 16% to 44% over the same period.

For nearly all users regardless of livelihood group the service is continuous. The exceptions were the highest households in the settlement: Households **4** and **5**. Household **4**'s service cut out after the morning peak demand period had passed and, like Household **5**, reported occasional weekend interruptions:

> It goes off in the mornings. I don't know why. And there isn't any on Saturday or Sunday. The pressure isn't enough for the slope. HH4

> Everybody does their washing on Sundays HH5

Table 24 Continuity of water service



Though there was a twenty-four hour service, households experienced interruptions a few times a year there are occasional interruptions[109]. These seemed to be accepted by users who attributed them to regular maintenance (urbane HH1 and 6) or short-term technical problems (traditional HH5) and even explained that the system had improved (diversified HH7, HH9). For Household **5**, for example, there was none of the mystery or frustration associated with stoppages in San Blas and Manco Capac.

> A pipe burst in August or September and we had to use the stream for a day — HH5
>
> It's improved. There isn't a shortage now. Before we'd run short in the dry season but this year we haven't suffered a shortage — HH9

Given the continuity of supply, views on service quality in these households centred on the lack of chlorination (urbane HH1, HH6, traditional

[109] In the urbane group this number was estimated by HH**1** at a day, twice a year and by HH**6** at a few hours, four times yearly. In the traditional group, HH5 and HH10 reported a handful of interruptions and in Diversified Livelihoods there were no more than 5 short breaks, five times a year.

HH10 and HH14, diversified HH2) and the suspicion that the water was not potable (diversified HH3, HH4, HH13). For Household 4, uncertainty over water quality entailed additional household expenditure on boiling drinking water:

> Chlorinated would be much better. The service has improved. Before there wasn't much water, now there are bigger pipes — HH1
>
> Well, it still isn't potable: it is piped but it isn't chlorinated. — HH6
>
> It's ok but it would be better if it was ready to drink because it costs us money to boil it — HH4

Household **10** harked back to the days of using the spring water and noted that for some houses this meant that there was no domestic connection:

> In the past, there wasn't any. We had the spring water but further up the hill, the houses didn't have any. The JASS said that they were going to chlorinate the water but there has been no news on that. — HH10

The continuity of service reduced the need for household storage in all livelihood groups. In Household 1, storage was not in response to a water shortage but to water quality: it was used as a rudimentary treatment method:

> I store water to let particles settle out, especially in the wet season. I store it in the evenings and let it stand overnight to use the next day. — HH1

Households **4** and **5** reported storing water in anticipation of high demand on laundry day (Sunday). Household 2, in the Diversified Livelihood category explained that:

> We store water because the tap is outside and we have to bring the water in. — HH2

Unique to Angostura was the attitude that paying for water was necessary and directly linked to maintaining and improving the system (urbane HH1, traditional HH5, HH8, 12, 14 and 15, diversified HH2, HH9) and regulating consumption (urbane HH6, diversified HH4). Household 1 thought that the price was reasonable since the service was "del pueblo", provided by the inhabitants themselves.

[The JASS] doesn't provide us with a good service in terms of the water quality, we ought to pay more. It only costs 2 soles (34p) and there are no meters so there is no awareness! The JASS loses out because they don't have funds to comply with their procedures; new pipes, maintenance...The JASS needs an income. And water is wasted: there are leaks inside houses. The "junta directiva" which chairs the JASS does not monitor domestic installations but twice it has gone house to house assessing the installations and 80% of households have inadequate installations.	HH6
It's ok but nobody pays. We need to pay to improve it. It has improved. Before there was less water now it is more constant	HH5
Down below, they wash clothes and turn the tap on and leave it on. They pay 2 soles (34p) per month so they don't care. In the centre of Cusco, where I used to live, they pay 10-14 soles (£1.70-£2.40) a month. People are inconsiderate! I don't agree with the price we pay because – although it's good for our household budgets – people take advantage. Here people use it on their chacras[110]...	HH4
It is necessary to maintain the water but it's still not chlorinated. It's up to the village to pay and that's ok. If we don't pay they cut us off but how would we have the water system if we didn't pay?!	HH2

The objections to paying for water were comparatively mild (HH5, HH8 and HH13). Household **8**[111] noted that in the past, there had been no need to pay for water. Household **5** objected on the grounds that the JASS was not doing anything with the money it collected:

We used to drink the water from Silkinchani [the archaeological reserve opposite Angostura]. Six years ago we didn't have to pay for water.	HH8
They charge us because there's a reservoir. Everyone in the association [settlement] works to clean it so I think it's a bit expensive	HH13

Households **4**, **10** and **14** thought that they would pay more with a water meter or if they lived closer to the centre:

It's fine. If we had a meter, how much would we pay then?!	HH10

Installation of the piped water system and waste water connections were recent and still recognised as an improvement. There was no water storage and an attitude to cost related to good service and a knowledge of more expensive

[110] This claim is not actually borne out in the accounts of irrigation given by the *chacreros*.
[111] Household **8** settled in Angostura in the early 1980s and still relied on agriculture for about half of the family income.

systems in the city. In terms of household experiences of water, the service ranked high on the WHO indicators for quantity, quality, affordability, continuity and accessibility.

6.4 Paths to Influence

6.4.1 State: national, regional and local government

The settlement has its own primary school on the right bank of the river but for secondary schools and the nearest health post, inhabitants have to travel north to San Jeronimo or south to Saylla, both about 10-15 minutes by bus. The nearest bus stop is on no more than a block or 5 minutes walk from most dwellings.

6.4.2 Central and Regional Initiatives

One of the president's comments identified environmental problems, such as the solid waste problem is issues could not be resolved at household level or in isolation from the rest of the municipality, or for that matter the river basin.

> With anything to do with environmental problems, we need support from the provincial and regional bodies.
>
> (Angostura President Interview 2006)

To this end, since 1996, Angostura, represented along with other communities by the District of Saylla, has been part of a wider group known as the Association of Municipalities for the Co-ordination of Inter-district Development in the Southern Valley of Cusco, or CID for short. The CID has been set up to improve living conditions in the Southern Valley and has started, with as much participation as possible, to draw up a Plan Integral de Desarrollo Estrategico y Sostenible (PIDES):

> The Inter-district Development plan makes the population the main actor/protagonist. Strengthening local institutions to guarantee sustainability throughout the process.
>
> (Municipalidad de Saylla 2002):3

This has fed into a strengthening of local authorities and efforts to bring together a wide range of state and civil society actors[112] with Saylla setting up a Department of Infrastructure and Environment and a Department for Basic Services in March 2006.

The Centro Guaman Poma de Ayala[113], described its role in the development of the Southern Valley of Cusco as follows:

> The Centro Guaman Poma de Ayala has played the role of facilitator in this process, promoting change from the grassroots. This means encouraging the direct participation of organized citizens in all the decisions that affect their future.
>
> (Gonzales et al. 2003):2

6.4.3 Municipality of Saylla

All families also pay the *autovalor*, or local tax, to the municipality. One consequence of this is that the services the municipality is able to deliver are limited. As the committee president explained with respect to waste collection:

> There's no service and we are polluting the river. It has not been considered in the municipal budget — HH6

There is a low opinion of municipal involvement which was limited to assistance with the flood response:

> The authorities should take on their responsibilities for helping us. They take us into account at election time but apart from that, nothing — HH4

Disappointingly, despite the participatory emphasis of the wider development initiatives in the southern valley, none of the households – except the committee president – mentioned this.

---

[112] Campesino Organisations, Neighbourhood Organisations, Women's Organisations, Youth Organisations (sport, culture, parish), producer organizations, political groups, institutions (church, university, NGOs). Actors from the state involved in the CID: District Municipalities, Public Institutions, Ministry of Health and Health Centres, Ministry of Agriculture: Water Boards, "Programa Especial de Titulaciones" PETT, National Institute for Natural Resources, Cusco Agricultural Agency, National Police and Ecological Police, District Governments, Ministry of Education: education centres, San Jeronimo Educational Development Area

[113] The project funding comes from two further, external actors: Gobierno del Pais Vasco and the NGO International Solidarity.

6.4.4 The Neighbourhood Committee

At a local level, Angostura has a community association[114] which has been running since 2004. The board, or *Junta Directiva*, is constituted by law and it charges subscriptions – collected by going house to house - which go towards its own administration.

Before 2004 the settlement had never been formally authorised and there had been no projects to provide basic services since 1990 (Angostura President Interview 2006). The process of authorizing the settlement, which includes compliance with regulations on the layout of plots and the observing the safety margin between dwellings and the river, is now underway at district level.

The Junta Directiva convenes community meetings (asambleas) and work days (faenas) and every household interviewed was involved. All households in the Urbane (HH1, 6) and Traditional Livelihoods (HH5, 8, 10, 11, 15) groups participated in the association's assemblies and elections and work days. The reasons for this high level of community involvement are the sanctions for non-participation (HH5 and HH11).

> Sometimes I don't have time but it's useful. If you don't go, there is a 20 soles (£3.40) fine — HH5

Several households in the Diversified Livelihoods group did not vote. In the case of Household 4, she had not been in the barrio long enough to vote but HH9 and 13 could not vote because they were tenants – this did not exempt them from participating in work days though:

> I go to faenas but I don't vote or go to meetings. The landlord goes... — HH9

The JASS, or water committee, was overseen by the settlement committee and this meant that the high participation also applied to this organisation with HH1 and 6 reporting that taking part was obligatory. Households in the traditional group, said that it was also useful to participate

[114] Strengths of the Junta were identified as: experience, transparency and management of their accounts, their ability to bring people together for meetings, technical support and planning. The president identified the main weakness as her being an outsider but also the fact that people drink during the faenas, lack awareness, leadership and administration skills, are still empirical – trying to sue former directors for embezzlement!

(HH5) to make sure that water was properly treated (HH10). Again the tenant households could not vote.

Those families with young children were members of the *vaso de leche* programme regardless of livelihood group (urbane HH1, traditional HH12, diversified HH2, 3). This participation involved attendance at meetings (rather than voting or paying subscriptions) but for HH3 – where the children were looking after themselves and perhaps needed the help most – access was constrained:

> I only go when [the vaso de leche organisers] are in the colegio because since my mum isn't here I have to look after my brother... HH9

6.4.5 Civil Society: NGOs and CBOs

The four non-governmental organizations or projects by external actors that came up were Centro Guaman Poma de Ayala, Solaris Peru and Coredor Puno-Cusco (HH6, HH10)[115].

Household **1** explained that the CGPdA had supported the installation of sewerage, treatment plants and pavements and Household **6** elaborated on this and the other organisations:

> Guaman Poma's support is centred more on the district of Saylla... World Vision provided toilets in the education centre and Coredor Puno-Cusco [116], a public sector organization gave courses on rearing small animals HH6

For households in the Traditional Livelihoods group, there was legitimate confusion over whether outside actors were public, private or NGOs. The waste water installations were variously credited to Guaman Poma (HH5, HH12, HH14), the maintenance man (HH8, HH10, HH15) and the district council in Saylla (HH14). If the family had paid the full costs, Guaman Poma did not get a mention. Household 12 said that the system had been paid for through participation in the "faena".

Those that were not aware of an assistance programme (or quite reasonably did not distinguish between private, public and civil society actors)

[115] CGPdA facilitated the installation of drainage, pavements (HH10, HH9) and run workshops (charlas) (HH4). Solaris Peru showed a video about giving birth and the risks of doing it at home "muy bueno el que trajo eso" HH4, HH2, HH9.
[116] This is a local development of the national development fund FONCODES (Guasch 2006)

where predominantly in the Diversified Livelihoods group and tended to work in agriculture: HH3, HH7, HH8, HH12, HH13, HH15. The exception was HH13 where both adults worked outside the home, in the centre of town and said that they were not sure about organisations assisting the settlement:

> I work outside. In the centre and I don't know when they have faenas — HH13

The president of the council also mentioned a micro-finance style savings and lending organization that had 22 participants[117]. The idea was to encourage savings over a two year period at the end of which time, members could yield up to 200dollars.

6.4.6 Private Sector involvement

The fact that security is low on the list of concerns for residents of Angostura means that there is perhaps less reliance on state level services such as the national police. Private sector involvement in security seemed to be an option in the face of disinterested local police, particularly for those with properties and businesses facing the main road. Households got together to pay for a night-watchman:

> [If there were security problems] we'd ask for some security guards. The police?! They are never going to come here, they'll say they have no staff — HH4

Two households (HH5 and HH14) said that Cervesur was helping to build the gabion wall flood defence with support from the mayor. Cervesur is the philanthropic arm of Cusco's brewery.

> Cervesur is building the [gabion] wall [the mother]. No that's a private company [son] — HH5

[117] Angostura's president described this as a "banquito communal" – a little collective bank. According to a report on the institutional players in the Cusco Region: "The Arariwa Association is a not for profit non-governmental organization, that has been promoting Andean rural development in comunidades campesinas for 18 years...[this involves] incorporating into people's daily tasks non agricultural activities, rural-urban co-ordination linked to the role of cities, a more regional and national vision of development, the promotion of micro-credit and the need to incorporate activities which promote the market as a strategic aspect of enabling rural development."(Gomez Villasante 2003):25

Private sector livelihood activity – other than household agriculture – was confined to the transport sector, home-based enterprises and some jobs in the city's service sector.

6.5 Livelihood Vulnerability: diversity and complexity in Angostura

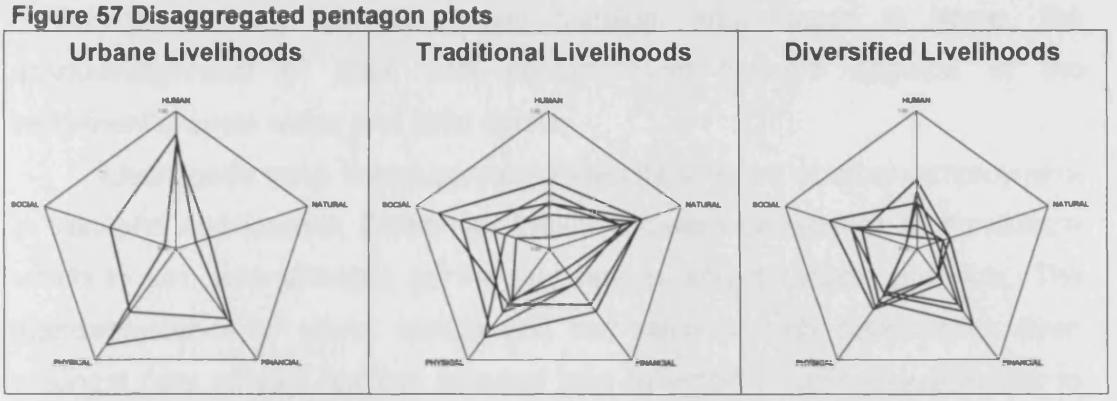
The livelihood themes began with Urbane Livelihoods the matronly figure (HH1) and the professional president and her extended family (HH6). These households were characterized by higher education, stable incomes and professional employment in the municipality or central government projects.

Next were the Traditional Livelihoods group with the bus mechanic and his farmer mother (HH5), the driver-farmers (HH8), farmer family with 16 grandchildren (HH11), the female-headed farmer (HH12), the farming couple with three children (HH15), the shopkeeper and carpenter farmers (HH10) and the PeruRail farmers (HH14). This group was dominated by agricultural activity, albeit in parallel with other home-based activities, and seasonal income insecurity, and levels of education hovering around primary or secondary school for adults but higher tertiary qualifications for some offspring.

In the last group of Diversified Livelihoods there were stronger links back to the centre of Cusco and beyond with waste-sorters (HH2), the abandoned children (HH3), the driver and vociferous, churchgoing wife (HH4), the newly arrived tenant farmers (HH7), the shopowner-labourer couple (HH9) and the taxi-photocopying couple (HH13). Here, cash incomes were higher but still seasonal and natural capital was lower especially in terms of land ownership.

In the pentagon plots (Figure 55), separated by livelihood profile, the Urbane Livelihoods resemble the dominant pattern in San Blas of strong Human, Financial and Physical Capital. Traditional Livelihoods are dominated by agriculture and Natural Capital. The Diversified Livelihoods appear to have a smaller overall asset base with relatively strong Financial Capital from the cash incomes derived from non-agricultural livelihood activities. Social Capital is strong across groups because of participation in assemblies and work days.

Figure 57 Disaggregated pentagon plots



Access to services was constrained by the small size of the settlement and the need to travel in to, or further away, from the centre of town to find healthcare, secondary schools, police and the municipal or electricity company offices.

Angostura was not served by the provincial water company but ran its own system. As an annex of Saylla District it was also lacking solid waste disposal services. Across households, however, the recent improvements and the changes to the piped water and sewerage systems are still remembered. There is virtually no household water storage because the service is so reliable and there is a prevailing attitude, unique among the case studies, which recognises the need to pay for the service and the awareness that their system is comparatively good and cheap.

Distinguishing actors by their governance category was fairly irrelevant to the beneficiaries. NGO involvement did not seem to be highly co-ordinated and engagement with wider regional initiatives appeared to be limited to the committee president and perhaps the JASS president. However, participation at the community level was strong. What came out strongly from our discussions was that the village council imposed sanctions on households that failed to participate in meetings or work days.

This chapter contributes to an empirical response to the research question by comparing the diversity and complexity of livelihoods in Angostura and examining elements of vulnerability that affect inhabitants, in terms of household assets, infrastructure and governance. In Angostura vulnerability was dominated by environmental shocks, centred on the settlement's relationship with the River Huatanay. This had several dimensions including

contamination from upriver; annual flooding; and, closer to home, the acknowledgement of their own contamination through disposal of the settlement's waste water and solid waste.

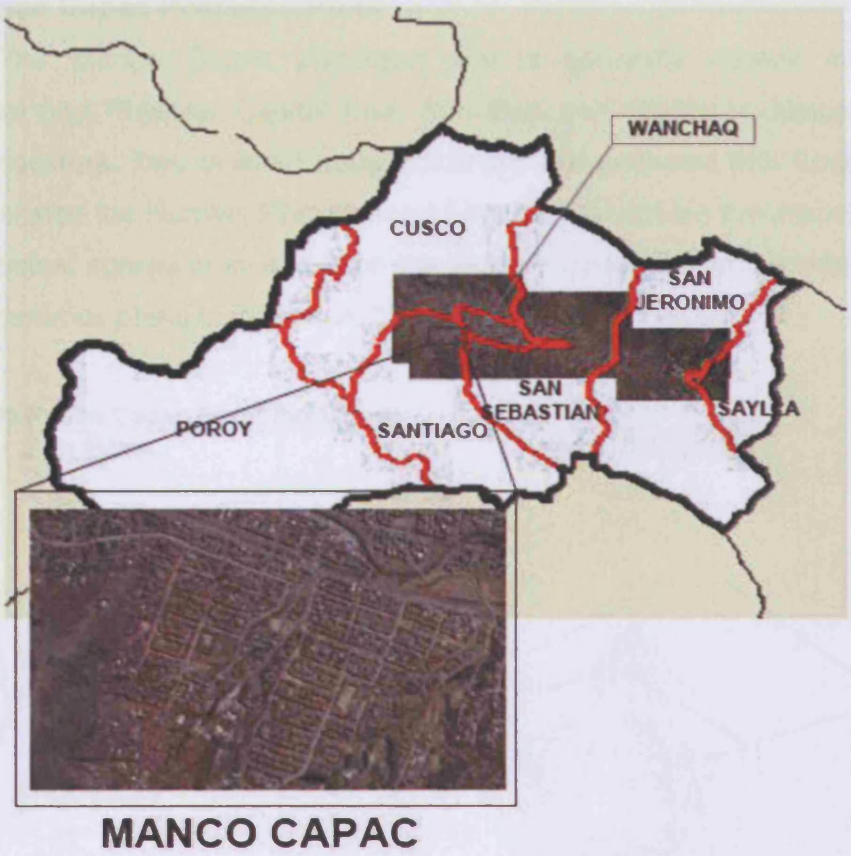
Livelihoods were linked upriver to the city in terms of urban employment in transport and tourism. Downriver livelihoods were dependent on agriculture which in turn was affected by the city upriver and its waste products. The interdependence of social capital and the value of high participation even amongst new arrivals (except tenants) was reflected in collective activities to maintain the water system and prevent flood damage.

Co-ordination of political or infrastructural activities across the settlement was well organised. This activity was linked to the municipality of Saylla through the settlement's president. Saylla's mayor was then linked in to regional level initiatives to orchestrate social development and integrate resource management. Although awareness of these larger scale activities seemed to be limited, formal governance structures were in place or emerging.

Chapter 7 Manco Capac: 'agua chocolatada'

From Angostura we travel back up the River Huatanay. On its southern or right bank, overlooking Cusco's main bus terminal and bustling bootleggers market, sits Manco Capac[118], the third case study. This community is within a thirty minute walk of the city's main plaza but is dependent on its own water supply, which falls outside the provincial SEDACusco system and is largely unsupported by civil society or local government actors.

Figure 58 Location of Manco Capac



The structure of this chapter follows the analytical categories set out in the Sustainable Livelihoods framework with livelihood profiles are themed as follows: Tenacious, Homebound and Landlord Livelihoods.

Manco Capac is now part of the District of Santiago, which lies to the North West of the city centre (Figure 56). Santiago was established as a parish between 1571 and 1572 under the Spanish viceroyalty, although, like San Blas it was predated by much older Inca barrios (Marco Cortez 1989). According to the municipal authorities, the district can be split into a rural area comprising ten

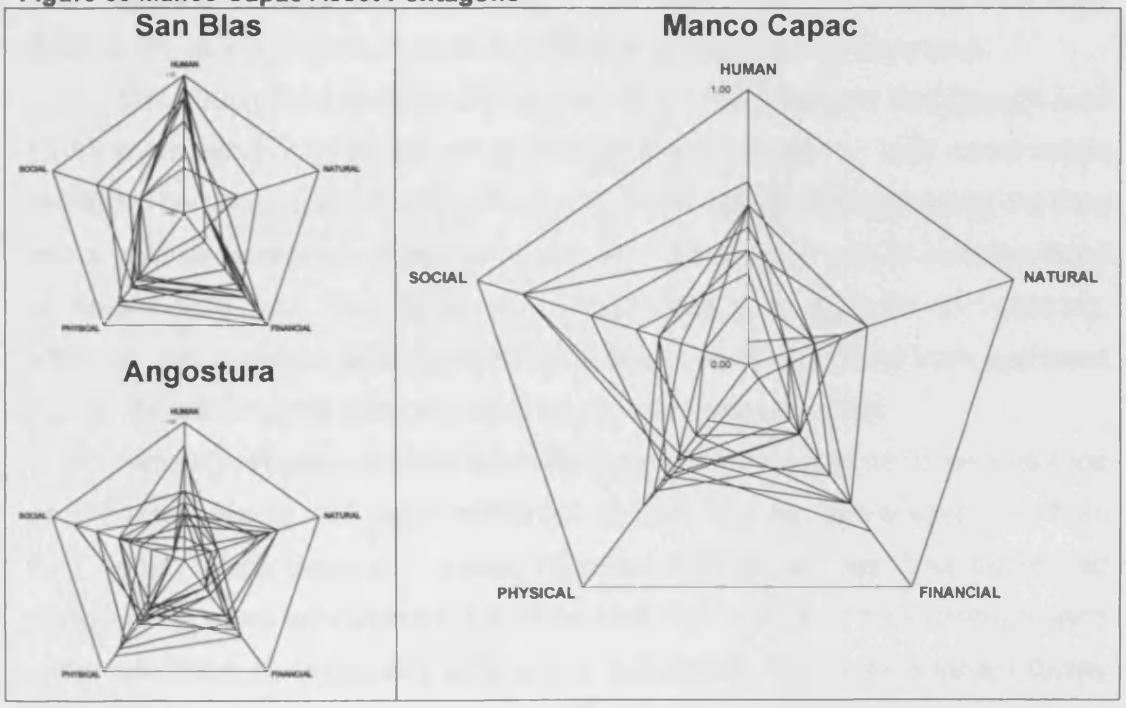
[118] Sometimes spelled Manco Ccapac.

campesina communities (3.9% of district population); marginal urban areas in four main zones totalling ninety-three settlements; and a central urban area of ten settlements. In 2003, the population across these areas was 85,831 (Municipalidad de Santiago 2008). Manco Capac is one of the ninety-three settlements described as marginal. The 2005 census data shows that across the district the dominant housing type is mud brick, or adobe, construction with 40% housing owner-occupied and 34% rented (INEI 2005).

7.1 Manco Capac Pentagon Plots

The Manco Capac pentagon plot is generally weaker in Human, Financial and Physical Capital than San Blas and weaker in Natural Capital than Angostura. Two or three households are well endowed with Social Capital but otherwise the Human, Physical and Financial assets are the important ones. The greatest spread in assets is on the Social Capital axis which reflects highly heterogeneous paths to influence.

Figure 59 Manco Capac Asset Pentagons



7.1.1 *Tenacious Livelihoods*: making ends meet inside and outside the barrio

This group is bound by a broad range of activities based both inside and outside people's homes and inside and outside Manco Capac. I deal first with the households that operate businesses from their premises and then with the households that generate their income in other parts of the city.

The interview with Household **35** was convoluted because the mother of the family was only able to lip read. The family relied on income from the head of household's work as a taxi driver and his wife's corner shop, which doubled as a *chicheria*, or local drinking-hole that was doing a roaring trade with customers reeling away at all hours of the day. Both parents said that they earned about 50 soles (£8.60) per day. Although this couple had not completed their secondary education, their daughter had graduated from high school and was working as a sales girl in the Molino Market for 280 soles (£48) per month. Her younger brother was still at school. The other members of the household were a distant relative and her baby. She was a single mother *"with no means"* who earned her keep as the family's domestic help. The family said their income did vary but attributed this to higher outgoings during term time.

The couple had lived in the barrio since childhood and had bought land 15-18 years ago but could not afford to build then, only able to start construction in 2000. Their house stood out in the group for its concrete construction but they had a yard large enough to rear chickens and guinea pigs and to park the head of household's taxi. The family used both gas and firewood for cooking, although the firewood was bought from street vendors rather than gathered locally. As with most of Manco Capac their street was unsealed.

Similarly, Household **38** derived income from the head of household's job as a driver, earning 400 soles (£69) per month, and his wife's shop, run from their home, which generated about 15 soles (£2.50) per day. The driver had completed primary school but his spouse had not. All four of their children were under 16: three at secondary school and one infant. This was a tenant family paying 100 soles (£17) in monthly rent[119]. They were typical in Manco Capac when they described their situation vis-à-vis household income:

[119] The other tenants were a younger couple with a two year old: they paid 50 soles a month.

> [incomes vary] because there is no work. The worst months are January and February because of the rain. HH38

The family had been in the barrio for 20 years but in this property for only 6 months: it was the typical tiled adobe construction but with cement floors and patio. They raised chickens and guinea pigs to eat and kept a dog for security.

Household **44** was also renting[120]. The parents of the first tenant family worked at the Molino Market, neither had completed primary education and they earned about 20 soles (£3.40) per day and paid out a monthly rent of 150 soles (£26). Incomes varied depending on business but for this couple the worst months were November and October. The family had been in the adobe house and the barrio for 3 years and lived on the sealed main road that ran parallel to the River Huatanay at the bottom of the settlement. They kept a dog for security but no other animals.

The head of Household **40** had completed his secondary education and other household members had gone further, with tertiary and university qualifications. Household **40** included the extended family: a sister and her family of five, a brother and his family of four, another bachelor brother enrolled in tertiary education and elderly parents, described in the interview as illiterate. The head of household ran an internet café from the premises and his wife ran the neighbouring grocery shop where she cleared around 150 to 200 soles (£34) of produce each month. With other adults variously employed in the family shop, as causal labour, a chef and a trainee teacher, the household was bringing in between 15 and 20 soles (£2.50-£3.40) from each of the six economically active adults. Any variation in income was blamed on increased expenditure during the school term. This family had been in the barrio for 22 years and in their present adobe house for the last 14.

What was interesting about the initial visits was that the head of household was extremely cagey. His internet café had lace curtains which were firmly drawn and he actually admitted that he was wary because his business was unofficial and he feared the dreaded SUNAT – the Peruvian taxation department.

The next three households drew most of their income from livelihoods based outside the barrio. The head of Household **36** was in his 60s and was

[120] The second family in the demise ran the *chicheria* next door but was not interviewed.

permanently employed at the hospital as a technician on a monthly salary of 470 soles (£81). His 30 year old son was also contracted at the hospital and was on 350 soles (£60) – although this was not considered by the others to be part of the household income. His daughter worked from time to time at the Molino Market and was not specific about earnings except to say that it "varied". The youngest sibling was still at high school and the only other family member was the daughter's 5 year old son. During the interview there were taps on the shuttered window through which the family handed out bottles of beer in return for a small fee. This sideline was not mentioned as a formal livelihood activity but the main room was stacked with crates. On the issue of income security, the head of household's daughter had this to say:

> [incomes vary] because there are little extra expenses... the worst month is January because December is an expensive month and because of the rainy season. And there are outgoings for the students. The best month is June because of the bonuses in the month of fiestas patrias (celebrations of nationhood) HH38

The family had been in the barrio for 40 years since its creation and lived in a typical tiled, adobe house with earth floors and patio.

Household **39**'s head of household was retired and drew a monthly pension of 500 soles (£86) and had also been in the barrio since its creation. His wife ran a *chicheria* from the property and generated about 20 soles (£3.40) per day. His daughter worked as a teacher, matching her father's pension with her monthly income. Her husband, with his secondary education, worked as a mobile phone salesman and earned 450 soles (£77) per month. Their 5 children were still in full time education. Household income did not vary much but, when it did, it depended on teaching contracts. The unusual feature of this household was that they still owned land in Saylla District – home of Angostura – where they cultivated maize irrigated, of course, by the waters of the River Huatanay. They also reared chickens in Manco Capac for domestic consumption.

The head of Household **43** was employed in a hotel in the centre for which he earned a monthly wage of 450 soles (£77). By coincidence his wife, with the same education level, worked as a cleaner for the Centro Guaman Poma de Ayala! From this she earned 324 soles (£56) per month which she supplement by running a shop from the house that she, her eldest son and her father all took turns to tend. This generated an additional 10 soles (£1.70) per

day but she described this as "subsistence". With the other child still at high school and the estimated monthly spend on the education fees and bus fares standing at 200 soles (£34), she also went to sell produce at the Molino Market.

> The worst months are January and February because nothing sells. We only get 5 soles (85p) a day from the shop. I've always sold things in the street and I go house to house to do cleaning. HH43

The family arrived from the countryside in 1996 but their youngest daughter, only 3 at the time, contracted giardia. They owned their property, though, and returned to settle permanently in 2002. Their house was the typical adobe construction.

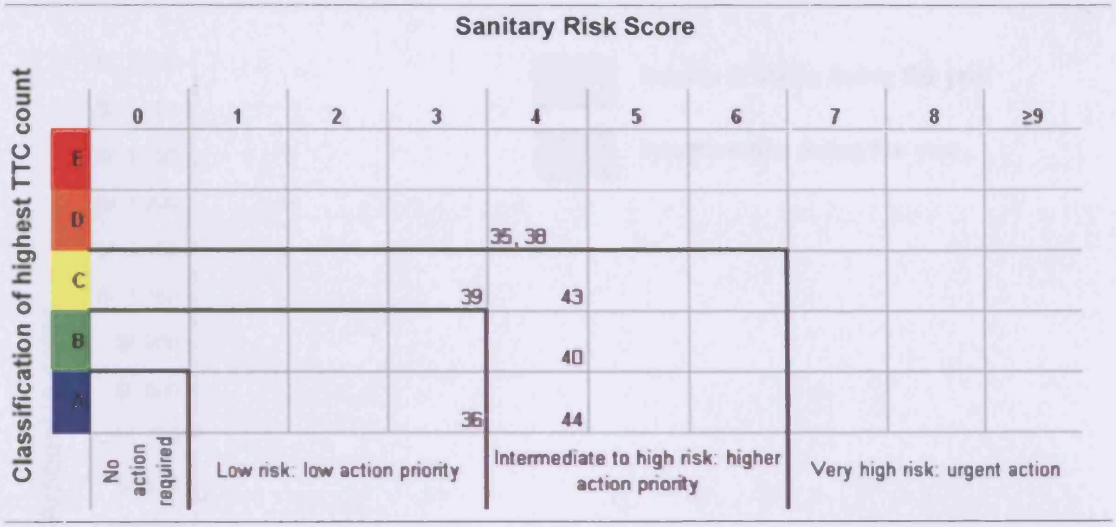
The summary table below (Table 24) shows the principal taps in each household and a sanitary risk chart based on sanitary risk scores and household sampling for thermotolerant coliforms. Two households fall in to the very high risk category, one in to the low risk group and the rest into the intermediate to high risk range.

The graph in Figure 59 summarises data on household income presenting it alongside reported utility costs. All households in this group, except Household 39, had variable incomes. The highest monthly utility bills were for electricity with water costing less than one sol per person per month. Electricity bills were highest in Household **40**'s internet café, followed by Household **39** where higher electricity consumption was perhaps linked to an expectation of stable incomes and formal employment.

Table 25 Household and Taps in Tenacious Group, Manco Capac

HH 35 'taxi-chicheria'	HH 36 'hospital and Molino'	HH 38 'driver and shop'	HH 39 'retiree, teacher, mobile sales'	HH 40 'internet and shop'	HH 43 'hotel and cleaner'	HH 44 'molino market'
7 people, 2 taps	5 people, 2 taps	9 people, 1 tap	9 people, 1 tap	16 people, 1 tap	5 people, 1 tap	12 people, 1 tap
			no photo	no photo		

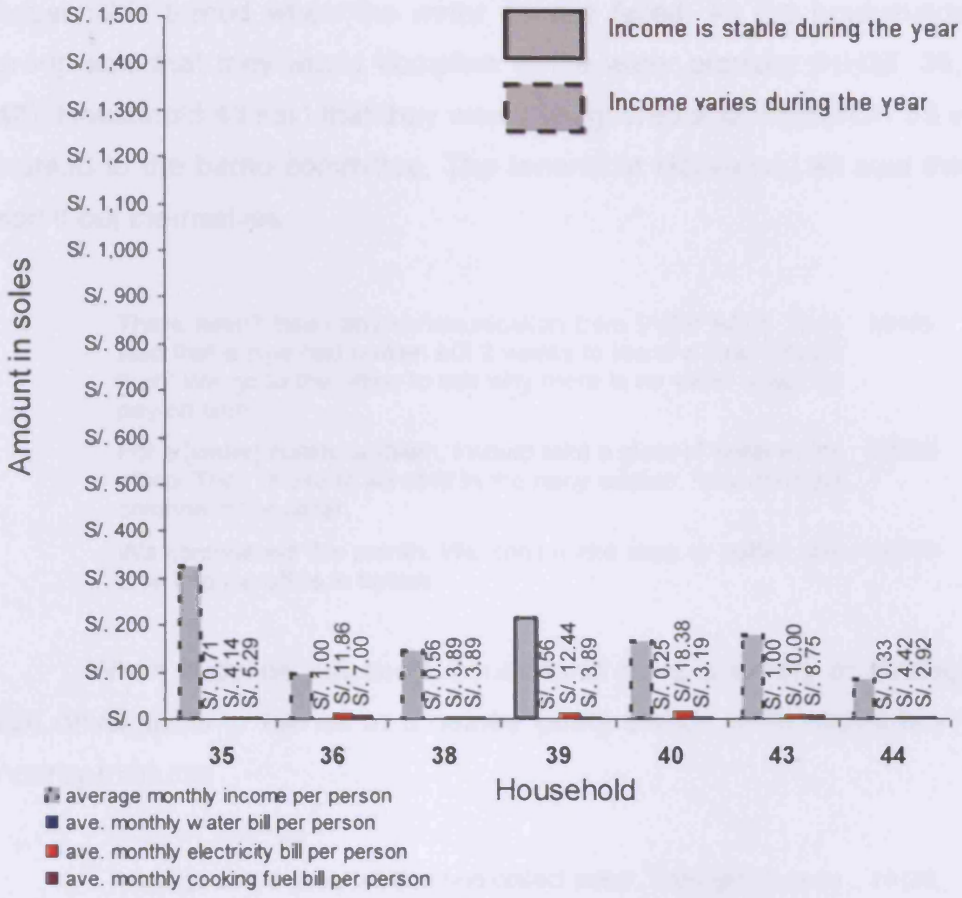
Figure 60 Sanitary risk score in Tenacious Group, Manco Capac



Householders estimated their daily water consumption in litres or bucketfuls. The highest estimate in this group was 20 litres per person per day in Household 43, where the couple worked in a hotel and the local NGO Centro Guaman Poma de Ayala. Other households estimated less than 10l/p/d and my estimates, based on questions around the volumes and periods of household water storage, also indicated very low daily water consumption between 10 and 35l/p/d. The water company estimated potential supplies of 64l/p/d (based on reservoir capacity and supply flow rates) but an effective supply of only 30l/p/d because of the poor performing network (SedaCusco 2007b).

The use of water in livelihood activities had changed over time with Households **36**, **43** and **44** using the water supply to make adobe bricks when their houses were first built. Only HH**36** still used this home-made adobe for patching up the walls after the rains had wreaked their annual havoc. Other uses of water for livelihoods included the taxi radiator (HH**35**), tending animals (HH**35**, **38** and **39**) and making *chicha* – the local maize beer – to sell (HH**39**).

Figure 61 Monthly income levels and utility expenditure per person in Tenacious Group, Manco Capac



In terms of Human Capital, household treatment of water and household illnesses related to water, boiling tap water was the rule, with only two families reporting anything different. These were also the two families reporting no water-related illnesses:

The children do drink water straight from the tap, yes. But the adults boil it	HH40
Yes we drink water direct from the tap	HH44

Those that reported illnesses mentioned intestinal (HH36, 39 and 43) and dermatological problems (HH35):

Parasites: one time my boy had spots all over his body which the doctors said was because of the water. It happens all the time. We have to boil the water	HH35
My sister went to hospital. She drank the tap water, there are bugs, parasites and worms	HH36

The interpretation of water-related Social Capital is based on where households turned when the water service failed. All the households in this group said that they would complain to the water provider (HH**35**, **36**, **38**, **40**, **43**). Household **43** said that they would be ignored and Household **39** would go instead to the barrio committee. The tenants in Household **44** said they would sort it out themselves.

There hasn't been any communication from [ASAPASC]. They said that a pipe had broken but 2 weeks to mend a pipe! What's that? We go to the office to ask why there is no water when we pay on time.	HH35
For a [water] quality problem, I would take a glass of water to the office. They refuse to admit it! In the rainy season, they don't put chlorine in the water.	HH36
We complained this month. We can't make soup or coffee. We take it to the office in bottles	HH43

When supplies run short, households have a variety of strategies. The taxi driver turns to friends at a nearby petrol station while others buy water at nearby markets:

I just go to the petrol station and collect water. They give it away to me because they know me	HH35
I get water from the market in Ttio [at the bottom of the hill]. It costs 20 centimos per bucket, per 18litre container	HH36
From lower down. Neighbours from Molino. Molino is in the "plan maestro", they have water from SEDACusco and they sell it for between 50 centavos for a 14 litre bucket and 1.5 soles (25p)	HH39
When we used to have a tin roof we used the rainwater	HH43
If there isn't any, we go somewhere else. To the house of friends	HH44

Households **36** and **38** reported that the only people that help are "el pueblo".

In summary, the households with Tenacious Livelihood profiles were involved in a diverse range of activities and linkages to markets beyond the neighbourhood were important. Outside the barrio these included employment in the transport sector and regional hospital, sales at a mobile phone shop and in the Molino Market, work in the education and tourism sectors, cleaning for an NGO and the cultivation of land in Saylla District. Within the neighbourhood, livelihood activities included home-based grocery shops, *chicherias* and an

informal internet café. The only household reporting income stability relied on the public sector and a formal sector sales job. Overall, incomes per capita were low and fluctuating.

At less than 1 sol per person per month, the water tariff was low relative to average monthly income but several households made expensive trips to buy water from elsewhere and also reported boiling water before consumption – an additional household fuel cost. Estimates of water use varied but were low. The relationship between these householders and their provider was fairly antagonistic.

7.1.2 *Homebound Livelihoods*: businesses inside the barrio

The three households in this group have livelihood activities that are confined to their homes and the neighbourhood: a shop, a bakery and a carpentry workshop.

Household **32** was female-headed. This 31 year old mother had not completed secondary education and had two children under 12 both still at primary school. She ran a home-based grocery shop from which she generated 12 to 15 soles (£2-£2.60) per day. The house was owned by this woman's father but she had lived in it for 8 years. Again, while others were struggling with higher spending on the household budget in term time, this shop-owner cleared more stock at their expense:

> It's ok during the school term but after that it goes down. January is the worst month. HH32

The next family in this group was slightly larger. The head of household **33** lived with his wife, their three children and his sister-in-law. All the adults had finished secondary and, along with the oldest child (11), worked in the bakery attached to their house. This activity brought in 70 to 80 soles (£12-£13.70) per day which was split between household members. The pattern of income variation was similar to HH**32**'s.

> [income varies] according to demand and according to the season. It goes up during school time HH33

Unlike the other households in this group the family did not own their house outright but were paying for it in instalments after buying it the previous year.

Household **41** was also a small family unit. The head of household was a 70 year old widowed housewife who told me that she was illiterate. She lived with two grown up children, one a student and the other a furniture maker. It was not possible in this case to pin down income because she was not sure how much money her son earned from selling his wares. She did, however, hint at the cash flow arrangements explaining that they borrowed money to buy the wood. Whatever the household income was, it was being supplemented by rearing chickens, rabbits and ducks, half of which were sold and the other kept for domestic consumption. Along with the others in this group, the fuel of choice was gas although kerosene and firewood were used as substitutes. She had been in the barrio for 40 years and told me that she and her husband had been among the first founding members.

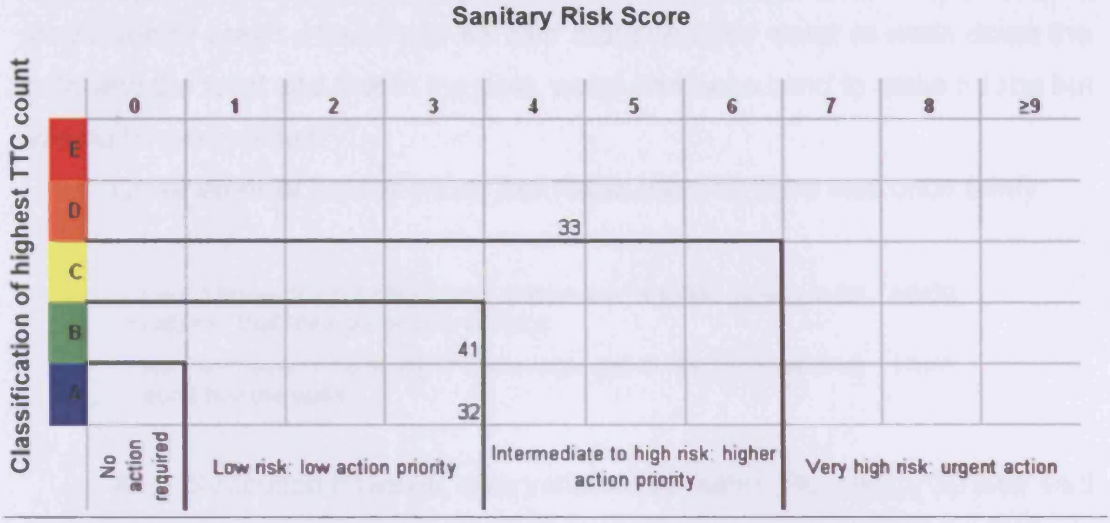
All these households were on sealed roads which for HH**33** and **41** was important for getting their goods to market (furniture is heavy and 80 soles' (£13.70) worth of bread is bulky). The house construction in all three cases was concrete rather than adobe, with tiled floors in HH**32**, cement floors in HH**33** and an earth patio in HH**41**.

The graphical summary in Table 25 shows the clutter of water containers in Households 33 and 42. The household busy producing food for sale to the public was also the one with the highest risk classification: thermotolerant coliforms were present in samples taken from the stored water (Figure 60).

Table 26 Households and Taps in Homebound Group, Manco Capac

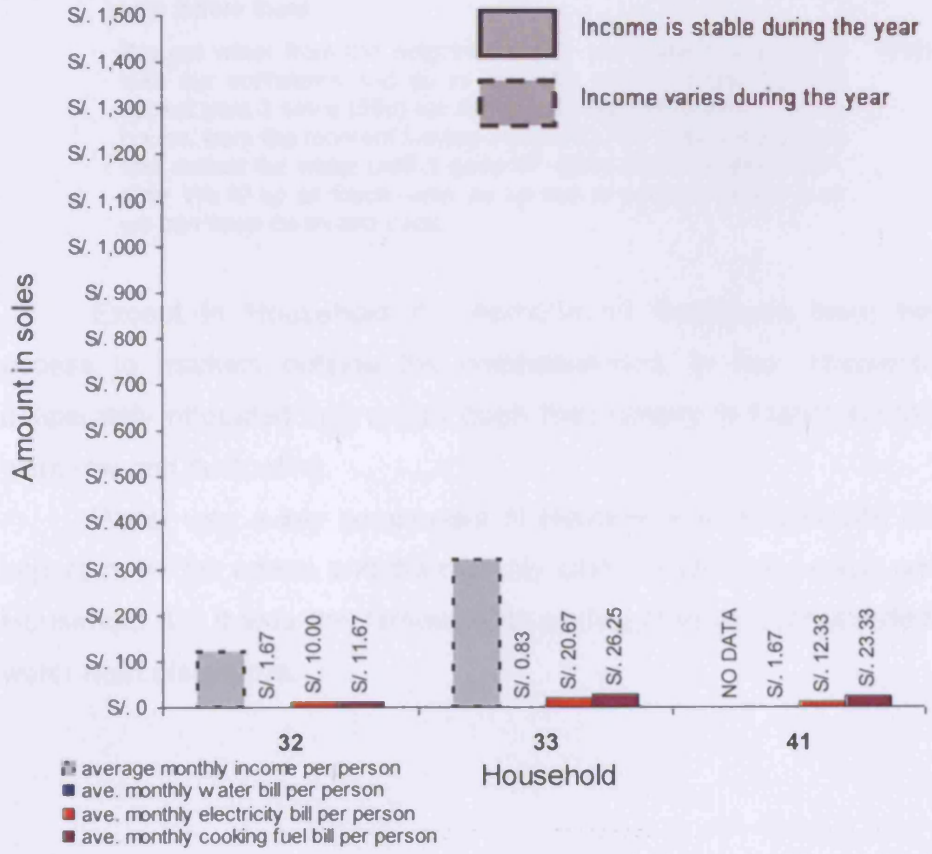
HH 32 'single shopowner'	HH 33 'bakery'	HH 41 'carpenter'
3 people, 2 taps	6 people, 5 taps	3 people, 1 taps
	 	

Figure 62 Sanitary risk score in Homebound Group, Manco Capac



Incomes fluctuated during the year with the bakery generating the highest monthly income and spending the most on energy in this group. Householders' estimates of water consumption were between 10 and 35l/p/d, corresponding to my estimates from stored volumes. Household 33 explained that the family used very little for themselves.

Figure 63 Monthly income levels and utility expenditure per person in Homebound Group, Manco Capac



Household **33** was using water in their main livelihood activity: the production of bread. Household **41** said that she used water to wash down the patio and the toilet and that in the past, water had been used to make adobe but was no longer needed.

On whether or not the water had made them ill, there was uncertainty:

I don't know. It's possible that it affects the "wawas" [quechua for babies], that they get worms or bugs	HH32
No [we haven't been ill]. People who get ill it's because they don't boil the water	HH41

As a precaution however, everyone boiled water. Household 32 also said that she used chlorine, adding drop of bleach (5.25% chlorine hypochlorite) per bucket to her buckets before refilling them (this showed in the water samples from her stored water). Households **32** and **41** collected water from Molino or Ttio markets, HH**33** fetched water from another house with a SEDACusco connection:

We get water from elsewhere. I have another house. A little house where there is potable water from SEDACusco. I pay to take it from there.	HH33
We get water from the neighbours. But some don't give it. We take our containers and go to Ttio. We pay 50 cents (9p) per bucket plus 3 soles (50p) for the taxi, 5 (86p) altogether. In the house, from the moment the tap comes on, we rinse the buckets and collect the water until it goes off again but it arrives turbid, dirty. We fill up as much water as we can in whatever there is so we can keep clean and cook.	HH41

Except in Household 41, homebound livelihoods were bolstered by access to markets outside the neighbourhood. In fact, Household 33 had deliberately relocated in order to open their bakery in Manco Capac. Incomes were low and fluctuating.

Water was a key component of Household 41's livelihood but was less important for the others and the monthly cost of water per person was lowest in Household 41. It was the families with young children that resorted to getting water from elsewhere.

7.1.3 *Landlord Livelihoods*: renting rooms

There are only two households in this category but they are unique in that the families own and occupy their homes but also let to others, as distinct from landlords able to live elsewhere. There are particular reasons for this that we will examine later but their label "landlords" – perhaps provocative in its negative connotation – must be seen in the context of what appear to be otherwise precarious livelihoods.

The first of these, Household **34**, was the most interesting. The head of household had been the president of the barrio at the time the water system was built. This meant he had had a seminal role during the foundation of the Manco Capac settlement and still represented Manco Capac on the board of ASAPASC, the local water committee. He and his wife, 63 and 58, neither of whom had completed high school, lived with their daughter and son-in-law (both educated to secondary school level) and two grandchildren. Both adult men worked as casual labourers, with the head of household bringing in about 100 soles (£17) per month. The head of household's spouse worked in the home, tending the guinea pigs and chickens raised for family consumption, while their daughter worked as a casual employee of the municipality.

In addition, the family let rooms to 6 tenants: a couple and their three young children in one unit, paying 50 soles (£8.60), and a 20 year old single man in another unit, paying the same amount. The young family derived income from the father's work as a casual labourer and the mother's job as a street vendor. The young man was also a street vendor. The let rooms were in a small new block built at the far end of the patio and were one sign, along with the cement internal floors, that the family had gradually upgraded their property since arriving 33 years before.

Despite the fact that their employment and that of one of the tenants was described as *"eventual"*, the family said that incomes did not vary. The household income was low, however, and when I asked about fuel for cooking, I was told that gas was only used in emergencies and that firewood was used to limit expenditure to about 4 soles (69p) per week.

Household **37** was remarkably similar in its set up with the principle couple in their late fifties living with their daughter, her spouse and two young grandchildren. The head of household worked as a casual labourer, earning about 15 soles (£2.60) per day, and his wife described herself as a housewife

but also worked as a street vendor cooking and selling homemade food at an umbrella covered stand at the corner of their street. This generated about 5 soles (86p) per day. The daughter described herself as a housewife and her spouse also worked as a casual labourer. Like their counterparts in other households, this family said that incomes varied:

> They vary a lot! There's no work in the rainy season HH37

Again, another source of income came from letting two rooms to a tenant in his late fifties and his elderly mother; he too worked as a labourer and paid 40 soles (£6.90) per month in rent.

Chickens were scurrying around the patio and the main fuel source for cooking (in the home and at the corner of the street) was firewood. The floors were all unsealed.

Both households had high sanitary risk scores and some of the reasons for this can be seen in the photographs in Table 26: uncovered water storage, hoses for filling containers and the lack of drainage for the earth patios. Thermotolerant coliforms were found in the samples from both households.

Household incomes were low but described as stable by Household 34 with his income from renting and other working adults (Figure 63). Household water estimates were low but even in these households with their twice daily water service, the additional inhabitants used up the water stored in assorted containers around the taps. Household 34 estimated their consumption at less than 5l/p/d, probably over 10l/p/d based on the stored volumes, and Household 37 simply reported using what they stored, less than 10l/p/d.

Table 27 Households and Taps in Landlord Group, Manco Capac

HH 34 'ex-president' 12 people, 1 tap	HH 37 'selling street food at the corner' 8 people, 1 tap
	

Figure 64 Sanitary risk score in Landlord Group, Manco Capac

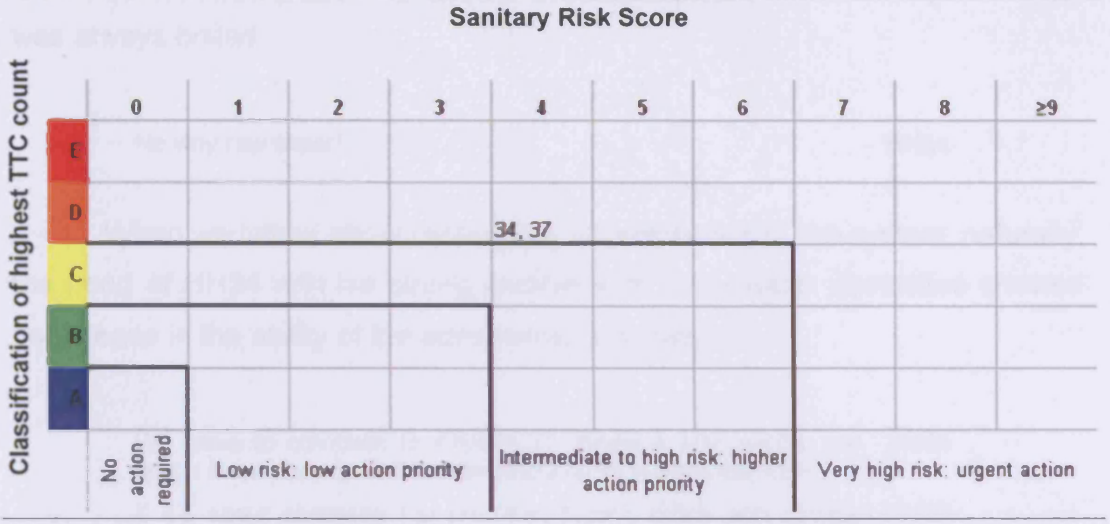
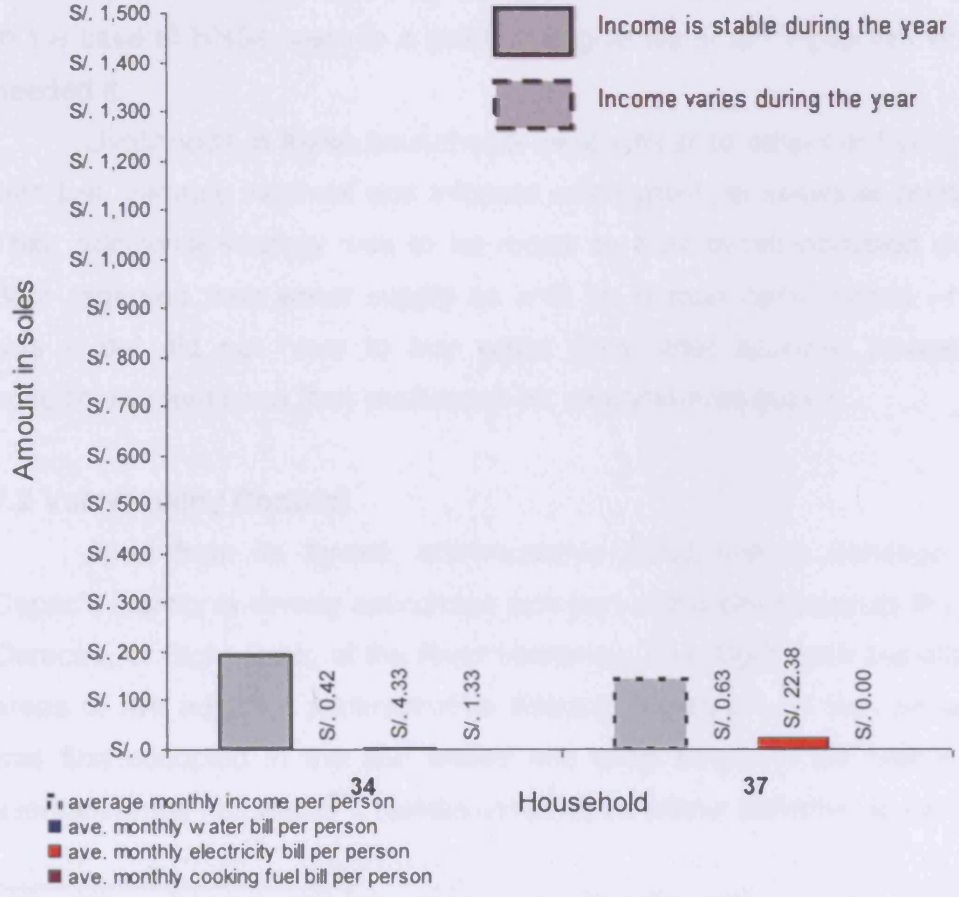


Figure 65 Monthly income levels and utility expenditure per person in Landlord Group, Manco Capac



Uses of water in the house were closely linked to livelihoods with both households reporting water for making adobe and other construction materials for their own (expanded) properties. Household **37** also used the water for producing the food that was sold outside on the street corner.

Neither reported illnesses from the water but were swift to say that water was always boiled:

> No way raw water! HH34

When we talked about responding to problems with the system, naturally, the head of HH**34** with his strong involvement in the water committee showed confidence in the ability of the administration to respond:

> We have to complain to ASAPASC. When a pipe bursts, we report it and they fix it. The administration is responsible for it HH34
>
> If it's about changing the provider, I don't agree with having SEDACusco because there would be meters. HH37

Both households said they didn't use other sources of water but instead, in the case of HH**34**, were in a position to give water to neighbours when they needed it.

Livelihoods in these households were similar to others in Manco Capac with low, variable incomes and informal employment in seasonal construction. Their additional strategy was to let rooms in their owner-occupied dwellings. Both regarded their water supply as unfit for human consumption – which it was – but did not have to buy water from other sources. Household 37 specifically mentioned their preference for an unmetered supply.

7.2 Vulnerability Context

Apart from its formal, administrative jurisdiction in Santiago, Manco Capac's identity is closely associated with part of the city known as the *Margen Derecha*, or Right Bank, of the River Huatanay. The Right Bank actually covers areas of two adjacent administrative districts: Santiago and San Sebastian. It was first occupied in the late sixties and early seventies by twelve original *asentamientos humanos*[121], human settlements whose definition is explained in

[121] The recognition of each settlement also tells a story of Peru's decentralization when one examines the officiating authority: Manco Capac founded in 1965, Tiobamba founded in 1968, Viva el Peru I and General Ollanta all recognised in 1971 and Chocco recognised in 1976 by the national Ministry of Housing and Construction; Barrio de Dios recognised in 1973 and Primero de Enero in 1976 by the South Eastern Regional Ministry of Housing and Construction; Wimpillay founded in 1974 and recognised in 1986, Araway in 1984, Viva el Peru II in 1985, Cesar Vallejo in 1989 and Villa Paraiso in the same year by the Provincial Municipality of Cusco.

Chapters 2 and 3. These groups took possession of the land, some buying it from the legitimate owners, others invading and winning land rights retrospectively. This process goes some way to explaining the current form of this area. According to a 1998 report on an aborted water project for the Right Bank produced by the Ministry of the Presidency, this area developed haphazardly, driven predominantly by the efforts of the population:

> Because of the illegal nature of occupation, [the zone] had neither technical advice nor surveys during its construction process. The sole objective was subdivision of the land. Nevertheless, once this aim had been consolidated, the inhabitants sought to improve their urban living conditions, trying to solve problems of linkages to the city, urban facilities, drinking water services, drainage, sewerage, electrification etc.
>
> (Ministerio de la Presidencia 1998):2

The population of the Right Bank in 1998 was estimated at 13,800 in 1998 (14.3p/ha) and by 2006 the municipal water company, SEDACusco was estimating this total at 16,208 people and projecting a 13% increase to 18,315 by 2020 (SedaCusco 2007b). This growth has also spread into 4 new settlements bringing the total to 16 in 2006. For Manco Capac, this represents equivalent population increases from 2,677 in 1998 to 2,987 in 2006 (and potentially 3,375 in 2020).

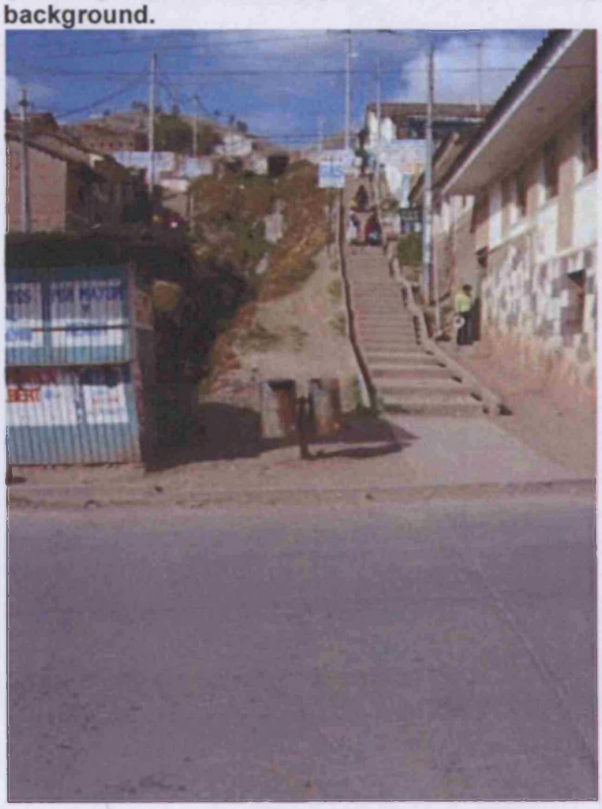
The Manco Capac "*asentamiento humano*", or human settlement, sits on the hillside between two natural gullies. It was founded on the 7th November 1965 but not officially recognised by the Peruvian Ministry of Housing and Construction until 1971. By 1998, Manco Capac comprised 526 plots, covered an area of about 178,000m2 and had 471 water connections or 90% coverage.

Of all the settlements in the Right Bank in 1998, only Manco Capac had a sewerage system and none had any sort of rainwater drainage. This lack of rainwater drainage must be seen in light of the zone's topography:

> The topography of the zone is rugged, presenting rocky zones, embankments with middling gradients, gullies with natural cuttings, gradients of up to 45 degrees in the slopes of the foothills and with depressions up to 100m deep.
> (Ministerio de la Presidencia 1998):1

Road access is limited and pedestrian access made treacherous by a combination of steep gradients, a largely unsealed road network, limited rainwater drainage and heavy, seasonal rainfall. Manco Capac is also listed as one of several critical sectors at risk of landslides and floods (Municipalidad Provincial del Cusco 2006). Figure 64 shows a flight of steps into the barrio running up parallel to one of the gullies.

Figure 66 View up into Manco Capac from main thoroughfare with overambitious recycling bins for separating organic and inorganic waste in the foreground against a waste-filled gully in background.



In Santiago as a whole, the main economic activities in 2005 were agricultural including complementary activities such as restaurants, bars and bakeries; sales and manufacturing; or transport related (assembling, selling and renting vehicles) (Municipalidad Provincial del Cusco 2006). In 1998, incomes in the barrios of the Right Bank were primarily commercial and agricultural with supplementary incomes coming from artisanal trades, letting rooms or setting up guest houses (Ministerio de la Presidencia 1998). Nearly 50% of the

economically active population described themselves as students with the next biggest percentage, at 6%, in sales and less than 3% in any other lines of work -either street sellers, teachers, mechanics, labourers, carpenters or drivers.

For anyone involved in construction or tourism, there is a seasonal impact on livelihoods with incomes dropping away dramatically during the rains.

The map in Figure 67 shows the location of Manco Capac on the steep sided right bank of the River Huatanay. The local employer, Molino Market, and the city's main bus terminus sit between the settlement and the river. The market and the bus station are the last buildings served by SEDACusco's water network on the southern side of the river.

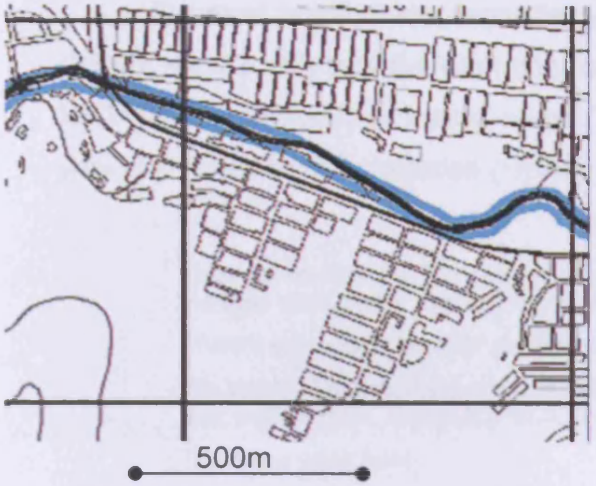
Figure 67 Aerial view of Manco Capac

Fly tipping site

The fly-tipping sites, gullies identified by Households 32, 33 and 41, run parallel to the steep steps up to the settlement and the waste water network discharges directly into the river.

The provincial plan shows both banks of the River Huatanay on its risk map as prone to powerful run-off and flooding, reproduced in Figure 66.

Figure 68 Manco Capac risk map from Cusco Provincial planning document



Risk Map Key

Risk of torrential run-off

7.2.1 Natural Hazards

Vulnerability to hazards was location rather than livelihood specific. Households **35**[122], **36** and **38** in the Tenacious Livelihoods category (mid-height in the settlement) and Households **33**[123], **32** and **41**, in the Homebound Livelihoods category (living on sealed roads) did not report any rain or flood hazards.

Tenacious Households **39**, **43** and **44** and landlord HH**34** reported annual flooding with assistance coming first from neighbours and then the fire brigade. Household **44** was the lowest house in the sample, located on a road parallel to the River Huatanay and Household **43** was the highest in the sample, on a steep unsealed road almost at the upper limit of Manco Capac:

> The houses flood. There is almost a lake further up at the ravine; the rain comes down from the mountains in the rainy season. We help in faenas. It overflows...there is no drainage. The fire brigade comes and uses motorised pumps. HH43
>
> Sometimes the River Huatanay floods. We just go to the dry areas HH44

Households in the Tenacious and Homebound groups wanted roads to be sealed (HH**35**, HH**36**, HH**38**, HH**43**) and pavements to be constructed (H33).

---

[122] Although Household **35** mentioned that there was a risk of flooding lower down

[123] HH33 mentioned the rain but only in the context of lightning, saying that the family stay indoors and that on one occasion the corrugate iron section of their roof had come off.

7.2.2 Security and opportunity

For most households, regardless of livelihood group, inadequate policing (HH40, 44, 33, 37) and the high cost of private security guards (HH35, HH36, HH34) compounded their fear of crime. The need to protect property individually was mentioned in all categories (HH39, 41, HH43 HH37).

There is no security. We defend ourselves. We call the police but they don't come; they say there are no vehicles or no fuel...	HH39
There's no security so each person has a dog.	HH41
We would like security guards but some people won't pay. We lack organisation. The police do come once in a while	HH34
There is a gang here.	HH37

A few households said that the police did come occasionally (HH38, HH39) and Household 32 in one of the best organized mini-committees said that there were no problems because they had contracted security guards.

Other issues were wrapped up in aspiration and opportunity with Household **33** bemoaning the lack of a high school, a church and a larger health centre. Household **40**, a self-confessed sports fanatic, wanted sports facilities for children to keep them on the straight and narrow. In the same vein, Household **36** wanted to be able to finance a professional education for their children. The plea of the landlords in Household 37 was to:

Change the attitudes of people from outside the barrio	HH37

Amazingly on two households mentioned the water system as priority for change.

The water service. Sometimes we start washing on Saturday then the water stops because we never know when it will be on and we have to take the clothes to Molino to rinse them	HH32
The water system: we are making a deal with SEDACusco	HH34

7.3 Infrastructure and Services

According to the census, in Santiago District as a whole, 87% of households had a water supply connection within their demise by 2005 compared to 72% in 1993. In 1993, 64% of households had a waste water connection compared with 89% in 2005. This does not give any indication either of the quality of supplied water or the treatment of waste water (INEI 2005).

The history of services in the Right Bank, however, is one of self-help with respect to house and road building and the water system which was installed by community *faenas*, or work teams, during their spare time at weekends and on public holidays over a five year period from 1985 to 1990. These days there exists something of a split between the 20% of Right Bank settlements in San Sebastian District and the others (World Vision Interview 2006). Those in San Sebastian got together to negotiate the intervention of SEDACusco in their water system and now have a drinking and waste water service provided by the municipal company[124]. The others have hung on to their own parallel administration know as the *Drinking Water and Drainage Association of Cusco's Southern Zone (Asociación de Servicios de Agua Potable y Alcantarillado de la Zona Sur Cusco)* or ASAPASC, as I will refer to it. In Chapter 8 we will examine this organisation in more detail.

The nearest primary school was run by an NGO in the heart of Manco Capac. For those at the foot of the settlement there is a state-run school in Ttio. There is no secondary school in the settlement and households use the school 15 to 20 minutes away in another settlement on the right bank: Viva el Peru. Manco Capac's health post closed down late in 2006 leaving inhabitants to use the centre 20 minutes away in Ollanta, a neighbouring settlement. The bus connections are on the main road parallel to the River Huatanay. For the households high up the settlement, the trip to and from the bus stop is steep and muddy in the wet season.

7.3.1 Energy

In Manco Capac, gas dominates as the preferred household fuel for cooking and this reflects the District of Santiago's census data with gas, firewood and kerosene at 22%, 72% and 2% respectively. Certainly, Manco Capac is on a site that has been cleared of any woodland that might once have covered it and is close to the city's markets for gas to be the fuel of choice. Some households reported using firewood however and it was on sale in little shops along the main road between the settlement and the river. Although most households reported boiling tap water before consumption, the water board

[124] Those now served by SEDACusco's system negotiated a "social tariff" which works out at about 10 to 12 soles per month compared to the fixed 4 or 5 soles rate paid to ASAPASC.

members of ASAPASC, said that people did not customarily boil water because of the cost of gas (ASAPASC Meeting 2006).

None of the households seemed perturbed by the handful of annual power cuts – although Household **41** with their Homebound Livelihood emphasised the need to secure the home at these times. Only Tenacious Households **36** and **40** said that they would complain about an interruption – Household **40** ran an internet café so had a strong livelihood interest. Strangely, along with the septuagenarian in San Blas, the oldest interviewee chose this moment in the interview to express her paranoia about the state's role in this:

> There was a power cut on the day of the elections. So that the votes couldn't be counted right. This hides the signatures of whichever illiterate person. The lights were off until about 8 or 9pm — HH41

7.3.2 Solid waste

The solid waste collection was fairly unpredictable with two households saying there was no service – it came so rarely – and the others reporting that the municipality of Santiago provided an occasional collection. Those with access to a container or close to a collection point – usually lower down the settlement near the main roads like Household **32** and **44** – left rubbish out for collection and reported much more regular collections. The consensus among others was tha*t there was no fixed timetable* and when the truck failed to come, they dumped their waste in the ravine *(tenacious HH35, HH36, HH38, HH39, HH40, HH43, homebound HH33, 41, landlord HH34 and 37).*

> Sometimes they don't come. It's too far, they don't want to come. Maybe they don't have time. You can go to the municipality but they pay no attention. They speak to the management who speaks to the administrator who speaks to the mayor... — HH35
>
> When they come, we put the rubbish out. When they don't we dump it in the ravine. — HH38
>
> Totally inadequate. The truck is small, sometimes it doesn't come and then the rubbish falls off while it's going along — HH33

Only Households **35** and **36** in the Tenacious Livelihoods category tentatively suggested that there might be a municipal tip. Everyone else, regardless of livelihood, either said had no idea where their rubbish ended up

(HH33, 41, HH34, 37) or suggested: *"higher up"* HH**38**; *the River Huatanay* HH**39**; *the ravine* HH**40, HH32)**. Household **43** was the only household to openly despair at this, sighing: "*we are polluting!"*

7.3.3 Waste water

In terms of waste water connections, the responses suggested that households connected themselves as and when they could afford it or felt the need to. However, regardless of livelihood group, all households had waste water connections and most had been installed by the families themselves[125] (HH35, 39, 40, HH33). The two tenant households said that the landlord had installed the connection. The two households in the landlord group had been involved in the initial sanitation project. Household **37** had had a waste water connection for 15 years and HH**34** for 25:

> The municipality and the population paid for the system. We manage it and the municipality gave us the materials. The population runs it. HH34

At the highest edge of Manco Capac, Household **43** had not been connected to the Manco Capac system but had more recently been helped by an NGO to connect to a neighbouring system:

> The drainage is World Vision's but it belongs to the new barrio Virgen de Rosario[126]. Each family paid 200 soles (£34.40) to the barrio then we had faenas, we collaborated. Our own committee doesn't support us [Committee 8]. Before we used to go to the ravine and the children went at school, so we were also polluting. Now we pollute the river. We pollute ourselves! HH43

All households in the tenacious and landlord categories confirmed that their waste water went into the network and then into the river. Only Household **36**, the hospital employees, exclaimed that this was terrible! In the homebound group, Households **32** and **41** did not make the link between their waste water and the river but the baker in HH**33** added that:

> [waste] goes into the network and then into the river. There's no problem with the sewage system. But for rainwater there is no drainage and it runs in the streets[127]. HH33
>
> It would be better with cleaning. SEDACusco doesn't take us into account and sometimes it pollutes the streets. People throw HH35

[125] with the exception of Household **40** who said that before 2000 they just used the "woods" and HH36 who had contracted others to do the work
[126] The barrio Virgen de Rosario is about 10 years old
[127] Also mentioned by HH39 in the Tenacious category

rubbish down the drains and they block.

> In the future, we're not going to be contaminating the river anymore: there is a project by SEDACusco to stop us but we don't know if we'll get it. For now, what we have works ok. HH34

This last comment was a reference to the famous "interceptor" drain designed to stop untreated waste from pouring into the river and conveying it instead to what will be a newly upgraded treatment plant at San Jeronimo. There are yet no plans to connect the Right Bank settlements to this collector (SEDACusco Interview 1 2006).

7.3.4 Water

Continuity of supply in Manco Capac is dramatically different from San Blas and Angostura. The picture is abysmal with water available only every other day and, even then, only for a couple of hours in the morning or evening.

What is interesting is that the two households in the Landlord Livelihoods category are distinguished by the fact that they have a daily water supply – albeit for only a couple of hours. The availability of water has enhanced their ability to let rooms and generate rental income. This is also the case for Household **38**, a property occupied by tenants.

Distinguishing irregular interruptions from the daily variation was unhelpful since the view was that the service was completely unpredictable but households in the tenacious group did report a recent broken pipe and worse shortages in the dry season[128].

This pattern goes some way to explaining the paraphernalia surrounding household taps. Families left their taps open permanently so that they would be alerted when the water supply began to gurgle through pipework and could then maximise the volume of water that they were able to collect and store. The close up of Household **35**'s yard in Figure 68 tells the story in gruesome detail.

[128] These interruptions happened from 10 to 15 times per year (HH35 and 44) up to 30 times a year (HH36). Apparently these interruptions lasted from a few days (HH36, HH38) to 2 or 3 weeks (HH35, HH39).

Figure 69 Continuity of water service in Manco Capac

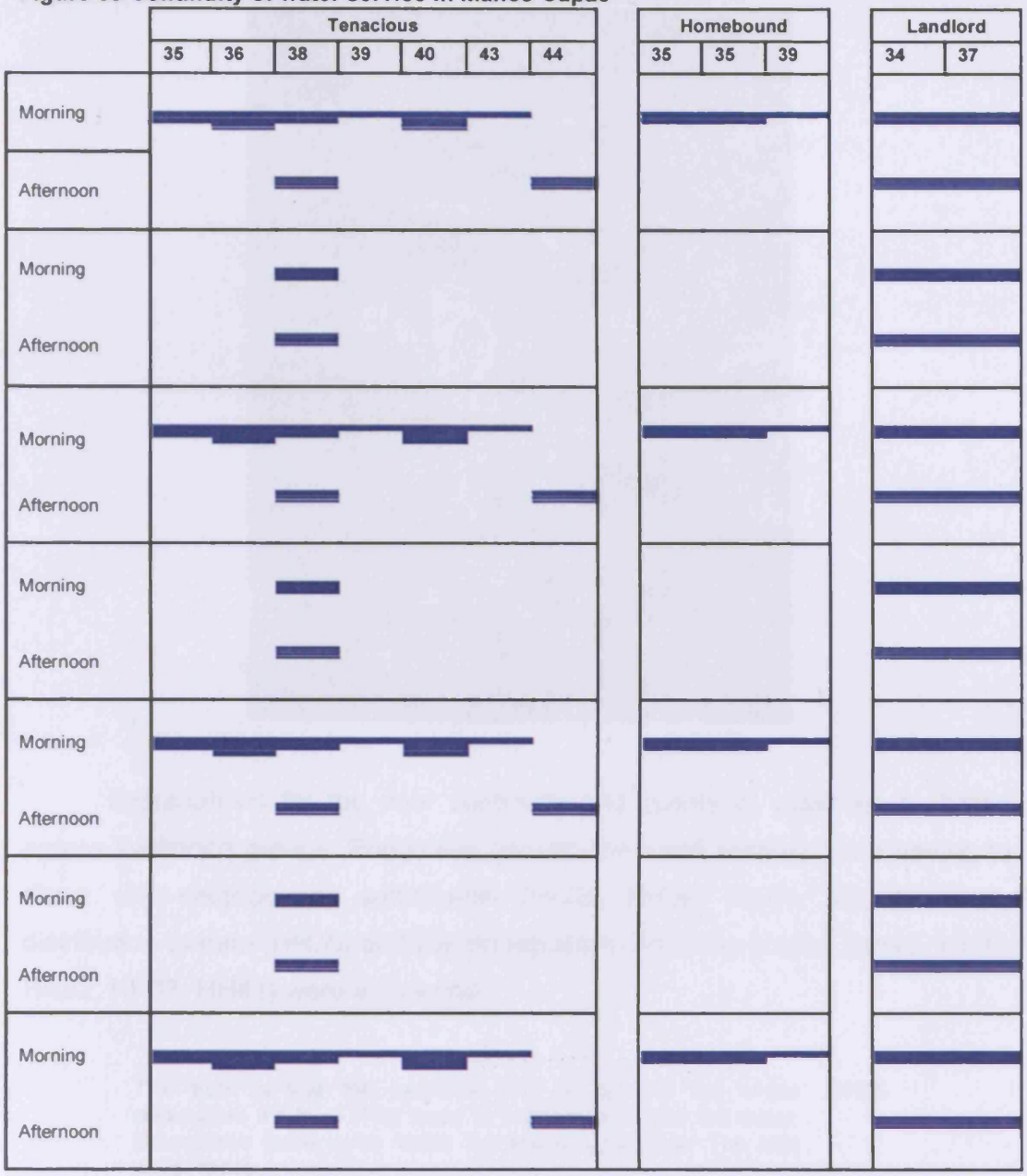
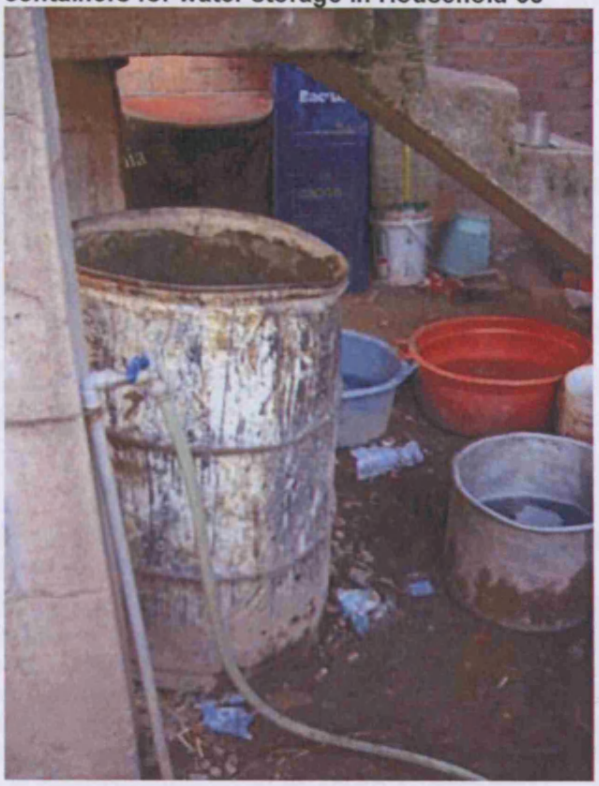


Figure 70 Variety of containers for water storage in Household 35



Explanations for the poor continuity and quality of water were shared across livelihood groups. Population growth, the small reservoir and having to share with neighbouring settlements (HH35, HH36, HH44, 38), the faulty distribution system (HH36) and the inadequate yield of the source (HH40, HH43, HH32, HH33, HH41) were all blamed.

> The truth is that the reservoir isn't enough for the whole population. It's bad. They need to improve and treat the water. Sometimes there is no water for washing the kids. The kids suffer most. — HH35
>
> There is a shortage because the water is also for irrigation. It's spring water and there is a community up there that uses it too. It's not potable. It's totally awful. My son drinks soft drinks because he says the water smells "ahuano" [quechua for muddy water]. The water stinks. — HH43
>
> They close it off so that other barrios can have it. It should be a constant service. That's what we need. — HH38

Explaining why Households 34, 37 and 38 all has a twice daily, 7 day service, the head of household explained that these houses sit over the main pipe that serves all the communities down the way. Even when supply is off in Manco Capac, it still has to run through the zone and this street can draw water.

This is particularly interesting since the heads of household and absent landlord played a key role in the construction of the water system:

> They distribute water to other pueblos. My home has water every day because we are on the part of the network that goes past [to other areas]. We are privileged unlike other houses. When they release the water to other barrios, I have water. HH34

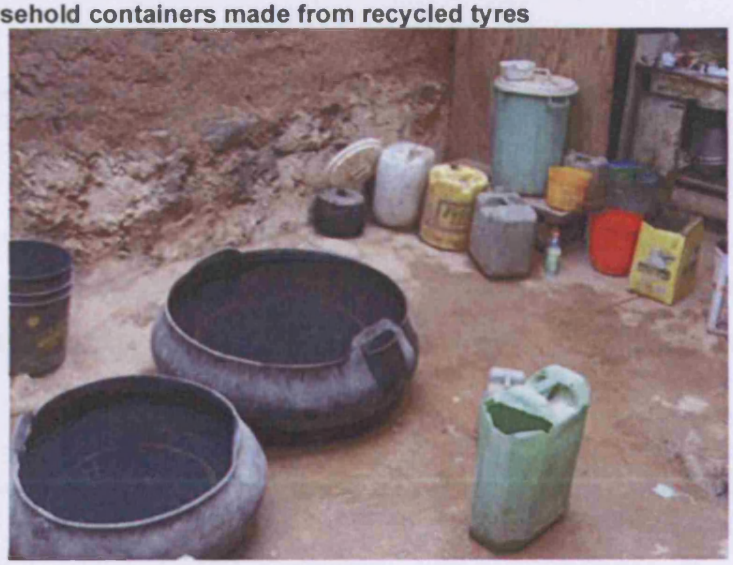
Households in the tenacious and homebound groups specifically mentioned transferring the system to SEDACusco (HH35, HH44, HH32, HH32, HH41):

> We want to change to SEDACusco. This would mean a better service but people are scared of water meters. HH35
>
> It's a small organisation [ASAPASC] that can't cope. The president of Manco Capac put forward a motion about passing the system to SEDACusco. The majority of people don't want anyone else [to supply water] so that they don't have to pay for more water. The directors don't want to let go of the responsibility. They make money from it. The management committee of ASAPASC doesn't want [SEDA to come in]. HH32
>
> I would prefer SEDACusco for the children. HH33

All households in Manco Capac have to store water regardless of livelihood group. The photograph below of Household **43**'s yard shows a typical scene with water stored in buckets with and without lids, jerry cans, drums and *tinas*, made from recycled tyres. This is summed up by Household 43:

> We have to store water at all costs, in everything we can find. HH43

Figure 71 Household containers made from recycled tyres



Containers were filled using hoses which were often riddled with holes and draped when not in use over the muddy yards, in amongst livestock[129]. On upgrading to a purpose built water tank Household **41** noted that:

> A water tank costs 350, 400, 500 soles (£60, £70, £85). We can't afford one of them — HH41

Views on the price that families were paying for this service were mixed. Those that objected to the cost generally did so on grounds of quality and the lack of treatment (HH35, 35, 39, HH32, 33, 41). Households **40** and **43** said that they would pay more if the service were better:

> I agree with the cost but I would prefer to pay more if we had water every day. Cars can't get up so we get thirsty carrying things up. It costs 200 soles (£34.36) to get reconnected [if they cut you off] — HH43

The three households with a twice daily supply – the tenants in HH38 and the landlords in HH37 and HH38 - noted that the cost suited them because it was unmetered:

> I agree with the cost because we don't have a water meter — HH38
>
> The price is ok because we pay less than we would with a meter — HH37
>
> Really, it is cheap. We pay 5 soles (£8.60) and since I have water on a daily basis, I benefit from it — HH34

All the tenants in Household 44, however, each paid 4 soles (69p) on top of their rent which meant that their landlord generated 12 soles (£2) per month from which he was easily able to pay the fixed, 5 soles (85p) water bill:

> The landlord pays the bill. We pay 4 soles (69p) on top of our rent. We don't have a house, so what's going to happen if we don't pay? He'll kick us out onto the street! — HH44

On the WHO indicators for continuity, quality, quantity and accessibility, householders experience a poor level of service. Only in terms of affordability does the system offer any advantages but even here, for the householders that

[129] A distinction was made by householders in **35** and **40** between water used for cooking and water not used for cooking. For example, Household **40** stored water for cooking for 2 days but other water for 3 or 4 days.

have to buy and transport water from elsewhere affordability is compromised. The important livelihood link is with the seasonality of income

7.4 Paths to Influence

7.4.1 National Government

The settlement's primary school is run by an NGO rather than government and attitudes to the police were dismissive. Otherwise the only interaction that any household mentioned with the state was the compulsory voting in general elections.

7.4.2 Municipality of Santiago

In geographic terms, the Municipality of Santiago is a long way from Manco Capac. Solid waste was the only service that people connected directly to the municipality and this was considered wholly inadequate.

> We complain to the municipality and they say that sometimes the staff haven't been paid or that the truck has broken down — HH39
>
> We need something three times a week. But it changes every time: it comes twice a month. People throw their rubbish into the street. The mayor's office....they are thieves. They don't think of doing anything for the people. They have to collect the rubbish. I didn't want to vote this year because he's a rat. — HH41

Households **34** and **37** expressed radically different views about the potential for getting their voices heard in the municipality. For HH**34**, the minority view was that collective action was the answer to poor service delivery and, for HH**37** and most of the other households, there was no solution and the reaction was complete apathy:

> When there's a problem, we would protest to the municipality, barrio by barrio, this works because we optimise [our impact]. That's the best way to do it. — HH34
>
> We don't do anything about it. We get bills from the municipality for environmental services but why would we pay? — HH37

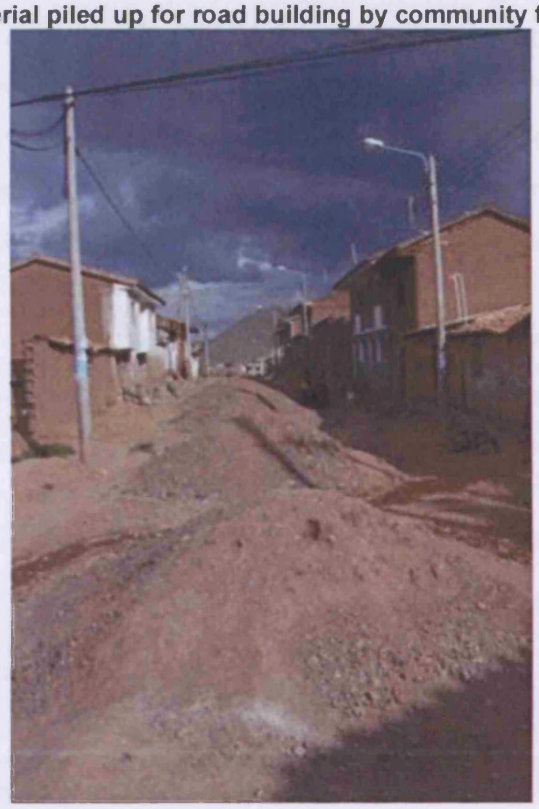
For its part, the municipality reported that the Right Bank was in massive arrears on payment of auto-valor or local council tax.

The relationship, or lack thereof, with SEDACusco was also a source of concern with some expressing a need for better water but others reluctant to be tied into a metered system.

7.4.3 The Neighbourhood Committees

According to the household and key informant interviews, the smallest unit of neighbourhood organisation is the *committee* which is made up of two residential blocks (with each block between 18 and 23 lots) (ASAPASC Interview 1 2006). In theory, these committees get together on Sunday mornings either to discuss projects or to carry them out in *faenas*, or work teams. The degree to which these organisations were functioning varied. Households on the southern edge of Manco Capac, like HH32, benefited from pavements, sealed roads and security guards that had been organised by the neighbourhood committee, while at the other edge of the settlement there was frustration at lack of coherence within the committees. On one of my visits, the Sunday morning meeting was being rather unsuccessfully convened by a whistle-blowing representative. The photograph in Figure 72 shows the preparation of materials for the annual road repairs.

Figure 72 Mounds of material piled up for road building by community faenas.



In the past, Manco Capac had also had its own president and board of directors but this community administration was not active in 2006. Most households in the Tenacious and Homebound Livelihood groups did not participate in a neighbourhood organisation[130]. Those that gave a reason cited lack of time and information (HH36, 40) or an organisation that did not function (HH36) or suspicion of organisations[131] (HH41).

> There is a management committee for the community but it doesn't function — HH36

Tenacious Household 43 attended the work days but did not participate in elections and both households in the Landlord Livelihoods category (HH34, HH37) participated in their block committee and worked on the roads:

> [we participate] just in the street to work on the road. We are contributing money: 500 soles (£86) per member. We have to attend to work in the road. — HH34

ASAPASC is the community organisation charged with providing water to several barrios along the Right Bank. Voting on decisions affecting ASAPASC's constituents is conducted at community assemblies. The right to vote is based on whether a person is a "*socio titulado*" or "titled member" of the Human Settlement and this, according to the legal constitution of the settlement, is determined by their name appearing on the *register of constituents*. A representative from Manco Capac sits on the board but the following quote from an interview with an NGO active in the area, gives a flavour of the set up.

> What happens here on the Right Bank is that there is a good percentage of the population that is renting. So, this population has neither a voice nor a vote at the assemblies of the APVs or AAHHs. Why? Because of their statutes, their internal rules. Only the members have access, like I said. We are talking about more or 30-40% of the population renting in the Right Bank, which is high. And they are maybe a large part of the population that wants SEDACusco to intervene.
>
> 11minutes (World Vision Interview 2006)

[130] Although Households **35** and **36** participated in the "vaso de leche" programme: "We have to go to meetings or you don't get your ration and it gets shared out between the others"HH35, "I go to collect the milk but I don't go to the meetings because I work in the day time" .

[131] This was consistent with her slight paranoia about the authorities, the elderly head of Household **41** said that she never belonged to organisations.

During the household interviews, on the head of household 34 in the Landlord Livelihoods category participated in ASAPASC.

All other households explained that elections were held only between the members of the board (HH38) and that ASPASC did not call meetings or inform people (HH35, HH37). The newest arrivals to the neighbourhood, Household 33, had paid a subscription to become a member of the association and this entitled them to a water connection. This amounted to a one-off payment of 180 soles (£31). One of the longest serving households, HH41, recalled that her husband had participated in the *faenas* which originally brought water to the Right Bank.

They vote amongst themselves	HH38
We are not told about it	HH37

7.4.4 NGOs and CBOs

World Vision (HH36, 39, 40, HH32) and Puririsu (HH37, 39, 40) were two NGOs named by householders[132].

World Vision's activity, however, is not centred on reforming ASAPASC since World Vision cannot intervene in the sensitive community decision to hand over their water systems to SEDACusco, their approach is rather to promote the "adequate consumption of water within the family": using boiled water, regularly cleaned storage buckets with lids and chlorination of water in the home. World Vision's other focus, providing school supplies, was obviously in response to the additional term time costs reported by so many households. Household **36** gave an angry response about World Vision, interesting more for the expectation that it implied than anything else.

It's fake. They take names of each family but don't give us anything. They give us paper and pens that are only worth 20 centimos. On the child's birthday they send a letter - not clothes or toys, just a letter	HH36

7.4.5 Private sector actors

Again, a few block committees had contracted security guards. Others had tried to organise private security but had been unable to rouse households

[132] HH**33** thought the regional government might be doing something but the responses were uncertain.

to pay for it. There was a desire for better security and the expectation that this would have to come from the community itself.

Household **38** mentioned the telephone company, Telefonica, explaining that this private company helped those on low incomes to buy school uniforms and stationary.

With the exception of the teachers and hospital workers, the formal and informal private sector was the main employer.

7.5 Livelihood Vulnerability: diversity and complexity in Manco Capac

Revisiting the livelihood profiles, the first label was **Tenacious Livelihoods** and included the taxi-chicheria couple (HH35), the hospital and Molino employees (HH36), the driver-shopowner tenants (HH38), the teachers and mobile phone salesman (HH39), the clandestine internet-shop pair (HH40), the hotel employee and CGPdA's cleaner (HH43), the Molino employee-tenant (HH44). These livelihoods were linked to formal activities outside the neighbourhood in the transport, education and tourism sectors; the market; the regional hospital. They also connected back into more informal neighbourhood strategies through grocery shops, the chicheria and an internet café.

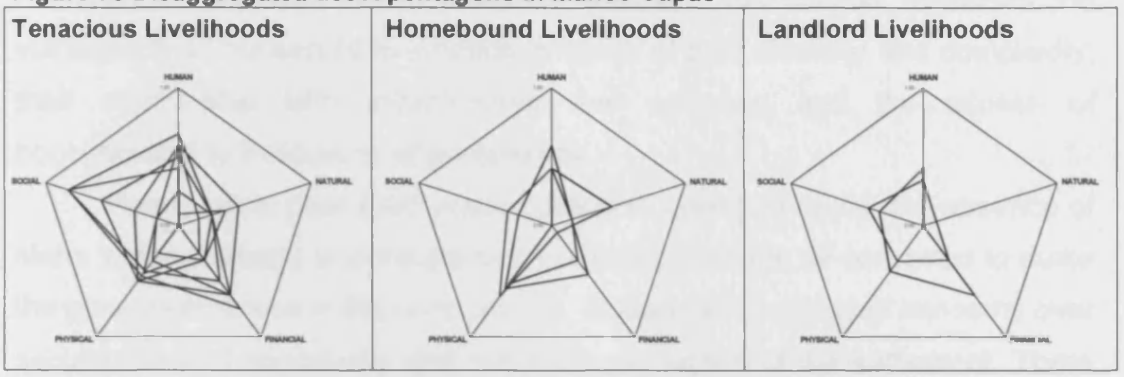
The three **Homebound Livelihoods** female-headed shopowner (HH32), bakery (HH33) and carpenter (HH41) operated production in Manco Capac but in two cases sold their products in the wider city. In the case of the bakery the family had relocated specifically to open their baking business. Transferring to SEDACusco was popular in the bakery which used water for production and had three young children in the household

In the **Landlord Livelihoods** group was the long-time local activist-manual labourer (HH34) and the street food sellers (HH37). These households were unique in the sample in that the families owned and occupy their dwellings but also let out rooms to others as distinct from absent landlords able to live elsewhere.

The pentagon plots, broken down by livelihood profile, reflect the low asset base of the Landlord Livelihoods group and the reliance on physical assets for home production in the Homebound Livelihoods category. The Tenacious Livelihoods profiles suggest higher social capital and reflect participation in local organisations and length of time in the zone. These

households relied on a combination of small businesses in Manco Capac and activities outside the neighbourhood.

Figure 73 Disaggregated asset pentagons in Manco Capac



Strategies to deal with water scarcity primarily involved household storage in an assortment of containers. Some households opted to pay for tap water collected from other parts of the city served by the SEDACusco system. One family reported lending water and another was observed allowing neighbours to fill containers up at their taps while the system was turned on.

Livelihoods were interdependent where neighbourhood businesses were vulnerable to seasonal unemployment in the rest of the city and where dismay over local infrastructure had prompted street level action to seal roads and build pavements. Households in Manco Capac discharged untreated waste water and regularly dumped solid waste into the River Huatanay's catchment but this was not an everyday matter of concern.

The attitudes to municipal government were negative and characterised by frustration with the lack of waste collection services on the part of the population and, from the municipality's point of view, arrears in local taxation. Some households expressed cynicism about the effectiveness of external NGOs like World Vision but were more positive about the local organisation running the primary school and offering teacher training.

Household attitudes to the water organisation ranged from despondency to suspicion. Interestingly, in many cases water scarcity was blamed on population growth or the limited spring source in the hills but rarely on the system itself. The views on whether the infrastructure ought to be handed over to SEDACusco, the provincial water company, were divided between those that

did not want their water to be metered and those that wanted a better service even at a higher cost.

As a response to the research question, this chapter examines the vulnerability of household livelihoods in terms of their diversity and complexity; their relationship with infrastructure and services; and the access of householders to institutions of governance.

Heavy rains, poor solid waste collection, unsealed roads, the absence of storm water drainage and the ad-hoc foul water drainage all conspired to make the zone treacherous in the rainy season. Households expressed concerns over security, lack of opportunity and outsider's perception of the settlement. There was also annoyance at the annual mud bath and surface water run-off but little preoccupation with pollution of the gullies or river.

Incomes were low and seasonal. Many adopted livelihood strategies that involved home-based businesses in the neighbourhood with supplementary activities reaching beyond the neighbourhood into the city's markets, transport and public sector. With many households focused on diverse livelihood activities outside the neighbourhood, participation over small areas – the block level committees – was variable. Where it was strong, the physical infrastructure was visibly better with roads and pavements built by the communities working together in their own time. Co-ordination of these activities at the Manco Capac settlement level was non-existent and attendance at settlement level assemblies and meetings was low.

Manco Capac was bypassed by the provincial water systems of Cusco and from the waste collection services of the municipality of Santiago. This was reinforced by distrust of the municipal institution and unwillingness to pay for municipal services. Manco Capac represented only one settlement served by a community system but much of the initial momentum that had driven construction of this system had ebbed away and collective action was splintered to an even finer scale: the level of housing blocks.

Co-ordination of political or infrastructural activities across anything larger than a housing block was limited. Governance of the water organisation was messy: users were alienated from it, communication between the provider and the users was poor and users were tolerating very poor levels of service.

Chapter 8 Vulnerability and socio-technical systems: a comparative summary of livelihoods and infrastructure in the case studies

In this chapter I formulate the next part of my response to the research question by conceptualising the interaction between vulnerability and infrastructure in terms of socio-technical systems.

The first stage of the argument is a comparative summary of livelihoods in each case study. This is followed by a detailed comparison of the social and technical dimensions of the water and sanitation infrastructure serving each place. I use the World Health Organisation's water service indicators to describe and differentiate system performance.

Through this analysis I argue that the different risks faced by households are mediated by differentiated levels of service. Then, by describing modes of organisation, governance of the provider, the number of users, the rate of drinking water production and, the spatial extent of the system, I argue that these differentiated levels of service are a function of the socio-technical configuration of infrastructure.

This forms the first half of my response to the research question and confirms, firstly, that vulnerability in this sample of households is mediated by socio-technical systems and, secondly, that these socio-technical systems are composites of the physical hardware and surrounding institutional software, not just of water and sanitation systems, but also other urban and environmental services.

In the following chapter, I bring this analysis to bear on the patterns of systems across the city and the connections and disconnections between hardware, institutions and households that allow risk to be shared. I also invoke the notion of splintering to explain how systems are shaped by processes of privilege, bypass, local resistance and networking between socio-technical scales.

8.1 Buffering risk I: assets and infrastructure

The sustainable livelihoods framework emerged from development studies as a tool for understanding how households face their vulnerability to environmental and economic change. It assumes that households are strategic in their behaviour, juggling a portfolio of different assets across five categories of natural, human, financial, social and physical capital.

Each case study told a different story of livelihoods, vulnerability, infrastructure and services and policies, institutions and processes. In the

following sub-sections these are synthesised in terms of the differential access to assets and infrastructure that result.

8.1.1 Buffering risk through household assets

The pentagon plots that opened the chapters on San Blas, Angostura and Manco Capac showed differences in the asset bundles of households within and between the case studies.

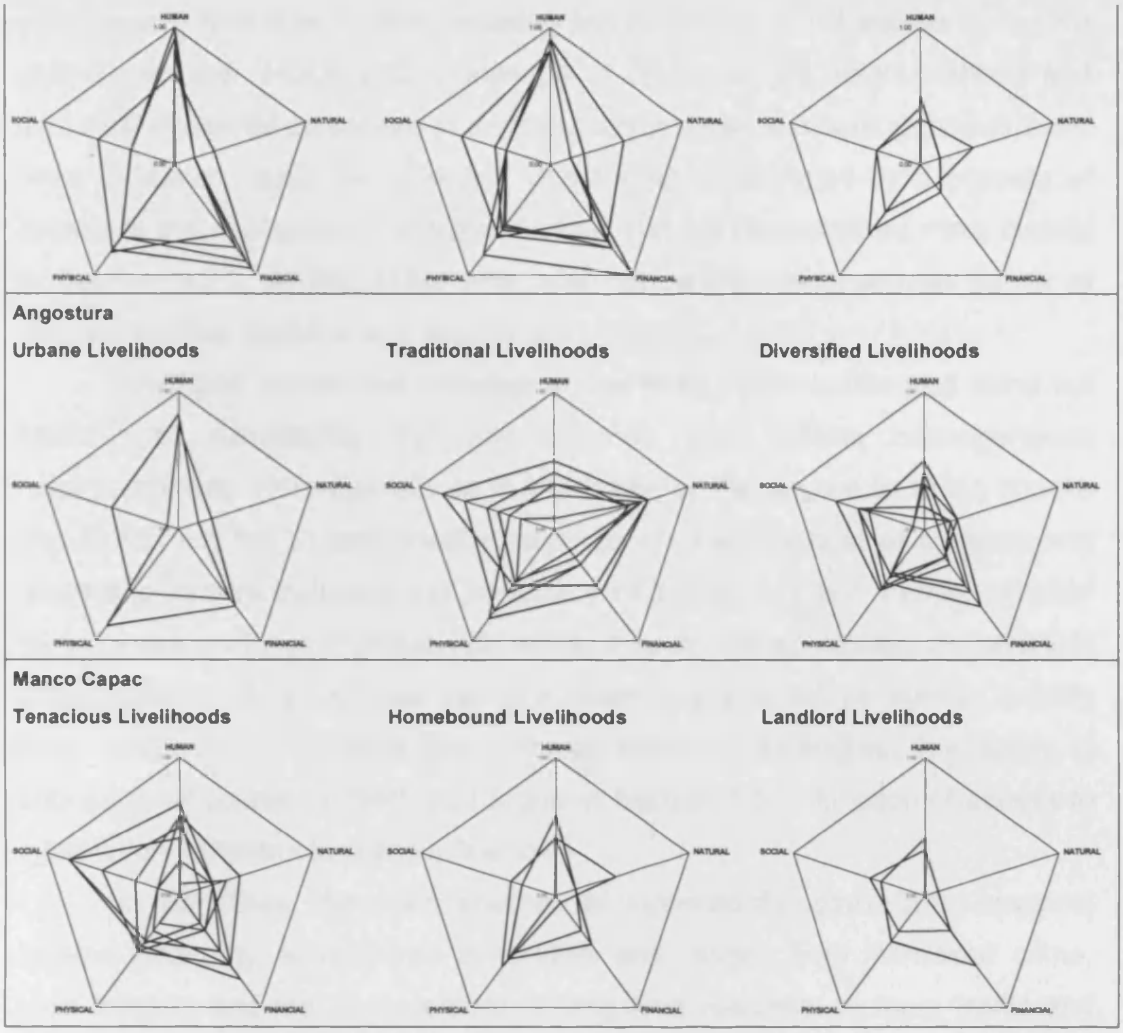
The sampling method deliberately sought out the widest differences and, at a glance, these plots show that even in the same neighbourhoods, it was possible to identify vastly different household asset bundles. The weak asset base of the 'excluded' in San Blas coexisted alongside both the 'establishment' livelihoods group, with their assets concentrated on the human, physical and financial axes, and the 'entrepreneurial' households with their weaker but developing human capital and occasionally unreliable financial capital.

In Angostura, the 'diversified' group with their low household capitals shared the settlement with the 'urbane', strong in human, physical and financial assets, and those with 'traditional' livelihoods, strong on the natural, social and physical axes.

In Manco Capac, however, the differences between the three livelihood groups were not as marked. In addition, the patterns of assets, apart from negligible natural capital across the households, were less easily characterised by their particular strengths. The 'tenacious' group relied on a combination of small businesses in Manco Capac and formal and informal activities outside the neighbourhood. These linked them to the transport, education and tourism sectors; the bootleggers' market; the regional hospital and back into Manco Capac through grocery shops, the chicheria and an internet café.

Meanwhile, for the 'home based' group, physical assets were used for home production, supplying the neighbourhood and wider urban markets. The 'landlord' group also relied on physical assets, this time to let rooms, although on other axes their asset base was weak.

San Blas		
Establishment Livelihoods	**Entrepreneurial Livelihoods**	**Excluded Livelihoods**



The contrast in each household's access to assets within the same case study and over very short distances echoes Richard Batley's observation that in cities the dynamic and marginalised sectors of the economy coexist (Batley 1997):339. He went on to observe, like Montgomery et al. and McAslan, that residential segregation – zoning that would split the living places linked to each of these sectors – could become something of a self-fulfilling prophecy where administrative boundaries locked in privilege by preventing cross-subsidy between municipalities. Montgomery et al. also suggested that localised segregation could enforce homogeneity in local networks of people and weak assets or resources, noting that ties to other sectors and actors in the urban economy were needed to mobilise additional resources (Montgomery et al. 2004)43:47.

This possibility of isolation from the wider resources of the city is also mentioned by McAslan (McAslan 2002):141. In Manco Capac, households with

weak assets lived side by side, isolating the zone from direct access to tourists and, as we saw, NGOs and knowledge of contemporary neighbourhood and municipal initiatives elsewhere in the province. A weak and homogeneous asset base in Manco Capac fed into and was further undermined by a process of bypass in the configuration of infrastructure that will be examined more closely in Section 9.2.2. At the same time, the household response was to try to connect to other systems and resources in the city.

Livelihood assets and activities in the three case studies also bring out features of vulnerability that are common even across heterogeneous neighbourhoods. Heterogeneity in vulnerability, or the degree to which shocks and trends are felt asymmetrically, depends on a whole host of complex and interacting factors including the frequency of the shocks and trends, whether these cycles are local or global, how easily they can be anticipated and whether, anticipated or not, a particular set of household assets will be able to smooth their impact through diverse and complex livelihood strategies. The ability to anticipate, of course, is itself, as I argue in Section 2.5, a function of access to information, infrastructure and influence.

In San Blas, the main sources of vulnerability, other than seasonal income insecurity, were linked to tourism and ranged from increased crime, local inflation and the displacement of long-time residents to more traffic and noise. Environmental vulnerability to the heavy annual rains was exacerbated for those with weak physical assets – poor quality or aged adobe houses – and those with the lowest financial incomes for whom the expense of renovating colonial era houses was burdensome. Otherwise the effects of overflowing foul sewers and poor storm water drainage depended more on location than livelihood, with the impacts concentrated where gradients were steep and surfaces impermeable. In San Blas, vulnerability was less about environment, infrastructure and services and much more about householders' links outside the settlement to international tourism and markets.

It was a completely different situation in Angostura where the major vulnerability, regardless of household assets, was linked to contamination of the river and the annual flooding. Connection of households to the environment was strong and there was unhappiness at the settlement's own contribution to the contamination. Additionally, people mentioned danger from road traffic and poor roads. Crime was regarded as low although households closest to the road had

clubbed together to pay for a night-watchman. Informally, interviewees talked about the lack of credit and human capacity. For Angostura, environment and vulnerability were closely connected and mitigating risk involved working together to draw in resources and labour to build flood defences or construct and contribute to collective water and sanitation infrastructure.

Manco Capac's serious vulnerability was in the low, seasonal incomes of householders. People also felt insecure in terms of crime and many reported lack of opportunity and outsiders' negative perceptions of the settlement. Environmental vulnerability was linked to heavy rains and the ensuing annual mud bath and filthy surface water run-off but there was little household preoccupation with pollution of the gullies or river with solid waste or untreated waste water. Manco Capac was experiencing a compound vulnerability associated with weak household assets, poor infrastructure and services, which exacerbated environmental hazards, and a lack of institutional support.

The patterns that emerge from the livelihood interviews have implications for vulnerability and the ability to buffer household risk. Firstly, where livelihoods were **seasonal and local**, based on labouring in construction or agriculture for example, incomes were low and unstable and human and physical capitals were weak.

The secondary effects of this were felt in Manco Capac and Angostura where **private neighbourhood services** like the grocery shops reported corresponding fluctuations in business.

Thirdly, there were also households with **seasonal and global** livelihoods that were strongly linked to tourism. Tourist numbers are seasonal with the Inca trail only advisable in the dry season and the annual adventure holiday market tracking the European and North American long vacations. Year to year, livelihoods linked to tourism are also likely to track the European and North American economic cycles. The sophistication of the service that households were offering to tourists also influenced their ability to capitalise along other axes. Street vendors hawking low value goods like local food or handicrafts had weaker asset bases. Landlords in San Blas who were able to let rooms to tourists could generate relatively high cash incomes but they had to be able to guarantee water services and personal safety. Similarly, the jeweller in San Blas was making high-end artisanal products for the international market which was more lucrative than employment in the public sector.

Fourthly, the livelihoods that could capitalise on their relatively strong human capital were much less seasonal and were linked to the **provincial public and private service sectors**: education, health and financial services. Urban public servants over longer cycles of change have not been immune from instability in Peru, however, with the crisis of the late eighties and early nineties showing just how vulnerable these sectors could be to inflation.

In terms of sustainable livelihoods, what is interesting about these urban vulnerabilities is that, although it is clear that those with seasonal, local livelihoods are the least able to build their resilience over time, there are two additional dimensions to differences in vulnerability. Firstly, different households in San Blas and Angostura are to some extent vulnerable to different risks at different times, while in Manco Capac the risks and vulnerabilities coincide. Secondly, an individual household is limited in the diversity of its risk buffering strategies because there are limits on the assets and actors and thus diversity and complexity in activities that a single household can contain.

The idea of spreading risk will come up again but the point to make here is that people-centred development gives primacy to the capabilities of individuals but a single individual probably cannot contain enough 'diversity, complexity and redundancy' to avert risks. A household may start to exhibit a range of skills, knowledge and assets so that its members can spread themselves across a variety of activities but as a household reaches the limits of what it can do on its own, its connection with other households, the environment, infrastructure and policies, institutions and processes becomes important. In fact, the extent to which risk is shared mutually may even affect the choices that individuals make about their capabilities and assets.

As we saw in Section 2.5.1, another perspective on collective vulnerability to risk comes from Debraj Ray's orthodox economic models of insurance which look at the exposure of groups of people to risk where the best insurance groups are subject to risks that are independent of each other or "idiosyncratic". Obviously, with a large enough group, all uncertainty is theoretically idiosyncratic and independent and smoothing can be achieved but the larger the group, the worse the flow and reliability of information about risk. By contrast, in a small, geographically close group, neighbours might have better information, a better system of social sanctions and better possibilities for

foresight, patience and confidence of the participants in the sustainability of the scheme (Ray 1998):601.

Reducing vulnerability and thus enhancing sustainability on this view is only possible by networking with other individuals who are subject to different idiosyncratic risks. And only by sharing information, perhaps across distances, could such a network be stabilised. The ability to do both of these things depends on the socio-technical configuration of infrastructure: modes of organisation, socio-technical scale and complexity and diversity in its connections.

8.1.2 Buffering risk through infrastructures: the lived experience of water and sanitation, differentiated services and differentiated vulnerability

Compounding the different risks mediated by household assets, the water systems in each place also present differentiated risks. This section examines different household access to infrastructure starting with water and sanitation and then comparing the more general experience of services and infrastructure.

The service levels delivered by each configuration of infrastructure are summarised with reference to the WHO's five key indicators: continuity, accessibility, quantity, quality and affordability.

8.1.2.1 Continuity, Accessibility and Quantity

Table 27 compares the case studies. Households in San Blas had daily interruptions but at least an intermediate level of access in that they had improved supply within their boundary walls. This contributed to a higher quantity of daily water. Angostura's system was almost continuous with households benefiting from at least one on-site connection. Manco Capac by contrast had poor continuity with households resorting to water from other, unimproved sources and lower overall consumption.

Table 28 WHO service indicators

Case Study	Continuity	Accessibility	Quantity
San Blas	Level 2: year-round service with frequent (daily or weekly) interruptions[133]	Intermediate access[134]	50 litres per capita per day (97 litres per per capita[135])
		Optimal access[136]	100-200litres per capita per day
Angostura	Level 1: year-round service from a reliable source with no interruption of flow at the tap or source;	Intermediate access	50 litres per capita per day
		Optimal access	100-200litres per capita per day
Manco Capac	Level 4: compounded frequent and seasonal discontinuity[137]	Basic access[138]	20 litres per capita per day (16.5 litres per capita per day[139])
		Intermediate access	50 litres per capita per day (30, 49 to 56 litres per capita per day[140]
		Optimal access	100-200litres per capita per day (30, 49 to 56 litres per capita per day[141])

In San Blas, there was a perception that water use was rationed by the water company and that even within the SEDACusco system, differential levels of service applied such that those – particularly businesses – in the historic centre were given priority over peripheral, residential areas. Some households in San Blas perceived themselves as 'central' and felt that they benefited from this while others felt more marginalised and that the increased tourism close to them meant that they lost out on water resources.

SEDACusco's CEO attributed discontinuity in San Blas to limited reservoir capacity, excessive demand and the practice of filling water tanks (SEDACusco Interview 3 2006). He did not distinguish between commercial users – laundries and guest houses catering for tourists – and residential users

[133] Causes: peak demand exceeding the flow capacity of the transmission mains or the capacity of the reservoir; excessive leakage within the distribution systems;
[134] Water provided on-plot through at least one tap (yard level), low public health risk
[135] From SEDACusco's published data. Household interviews showed a range of 49 to 108 litres per capita per day for those with intermediate access and 22 to 125 for those with optimal access.
[136] Supply of water through multiple taps within the house, very low public health risk
[137] peak demand exceeding the flow capacity of the transmission mains or the capacity of the reservoir; natural variation in source volume during the year; volume limitation because of competition with other uses such as irrigation; periods of high turbidity when the source water may be untreatable;
[138] Within 1km/within 30min round-trip, high public health risk
[139] Estimate based on reports from household interviews: 5no. 18litre buckets per household with average household size 5.47 people from SEDACusco
[140] Lowest estimate reported by SEDACusco in their survey report. Second range based on population, reservoir capacity and ASAPASC operating hours (ASAPASC 2005)
[141] Lowest estimate reported by SEDACusco in their survey report. Second range based on population, reservoir capacity and ASAPASC operating hours (ASAPASC 2005)

although he did recognize that storage was a response to the water company's poor reliability record:

> ...In San Blas, I understand that we have already substantially improved the hours of service. Of course there are occasionally interruptions...this could be because of variations in the demand of the population. Sometimes, there is an excessive [demand] and the reservoirs empty... perhaps, it gets [cut] because in this sector ... we are changing a pipe diameter in order to improve the flow capacity of the pipe... there are lots of people that fill up their cistern... but we also know that that it is linked to the reliability of the water company. If we give them confidence that they'll have water all day, guaranteed, they won't use their cisterns. But to do that, hopefully, we are just waiting/hoping to finish a project. Hopefully, we'll be able to put it in operation and we hope to improve the whole supply system and that will [in turn] change people's habits a little bit.
>
> (SEDACusco Interview 1 2006)

In Manco Capac, insufficient water at source meant that the water service was split between different sectors on different days. ASAPASC's "Cronograma de Distribucion" is reproduced in Table 28 to give an idea of the level of intermittence experienced across the Right Bank (ASAPASC 2005):

Table 29 Water service schedule in the right bank

SECTOR	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
Manco Capac (1-3) Manco Capac (9) Manco Capac (all)							
Viva el Peru I (1-3) Viva el Peru I (4-8) Viva el Peru II							
Primero de Enero							
Chocco							
Tiobamba (upper) Tiobamba (lower)							
Virgen de Rosario (upper) Virgen de Rosario (lower)							

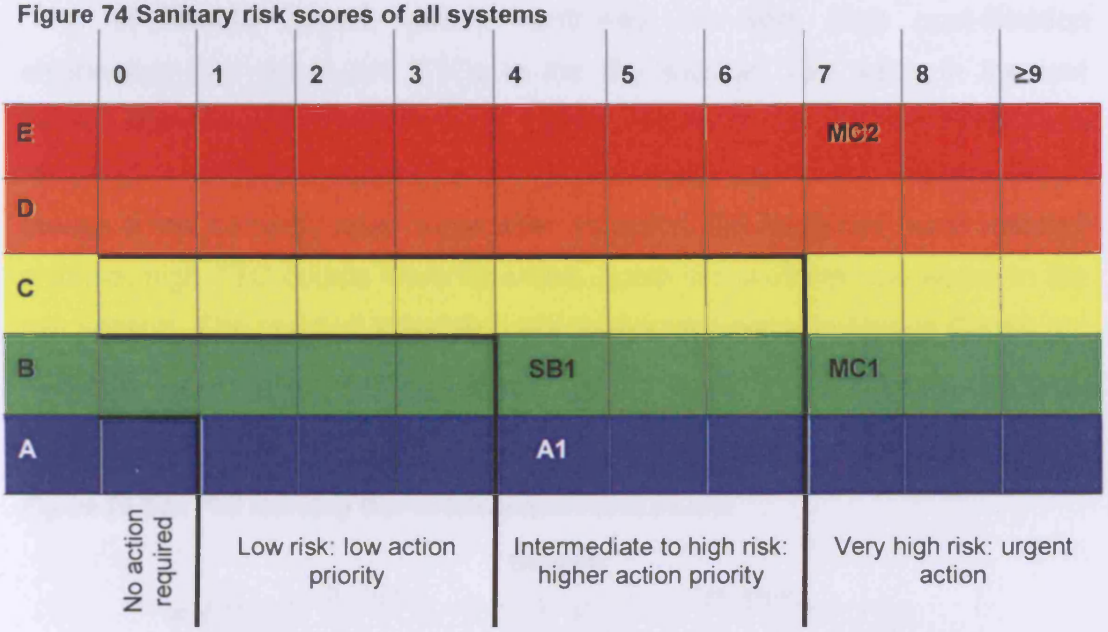
The situation has got progressively worse. In 1998, most settlements had water between 8am and 6pm everyday and only the highest settlements had a rationing schedule limiting water availability to 2 days per week and 4 hours per day (Ministerio de la Presidencia 1998):6. The distribution timetable was summed up by a member of the maintenance team during one of the site visits, when he said sadly:

> It's necessary. But it's not fair.
>
> (ASAPASC Interview 2 2006)

8.1.2.2 Quality

In terms of quality, differential sanitary risk is also apparent in each supply system. Figure 74 shows Manco Capac's surface source (MC2) with high thermotolerant coliform counts and the surface and spring (MC1) treatment systems with high risk scores. Angostura and San Blas both had low TTC counts and intermediate risk scores. Original results are shown in Appendix D.

Figure 74 Sanitary risk scores of all systems



The box plots in Figures 73 and 74 show the results of household water sampling. Thermotolerant coliform counts and residual chlorine results are shown for each case study, disaggregated by season and by whether the sample was collected from running taps or stored water. Box plots are useful for displaying differences between the case studies given the typical, highly skewed distribution of TTC counts (shown in Appendix D). The construction of the central box is based on the first and third quartiles of the data set. The median is shown as a line through the box and outside the box the largest and smallest non-outliers are marked by bars. Mild outliers (greater than one and a half times the inter-quartile range) are shown as closed circles and extreme outliers (greater than three times the inter-quartile range) are shown as stars.

TTC counts in San Blas are low which is consistent with the carefully controlled treatment and disinfection at the Santa Ana Plant. The range of residual chlorine levels was wider in the wet season. This indicates the

treatment plant's response to much higher turbidity and production rates in the wet season and the technical difficulty of controlling this.

In Angostura, households tended not to store water so the "buckets" category is empty. There is also no treatment and no chlorination in this system. TTCs were recorded in several households and the counts were higher during the wet season when patios, waste connections and tap stands were frequently inundated.

In Manco Capac, poorly controlled but very high post-filtration chlorination had eliminated TTCs in the dry season. Tap water in the wet season had lower and less variable levels of residual chlorine and TTCs were recorded in several households. In stored household water samples, even though a few samples taken soon after collection still contained some residual chlorine, high TTC counts were recorded, again this problem was worse in the wet season. The residual chlorine outliers in stored water in Manco Capac are accounted for by one household where the family added a few drops of bleach to storage buckets as they filled them.

Figure 75 Box Plot showing thermotolerant coliform counts

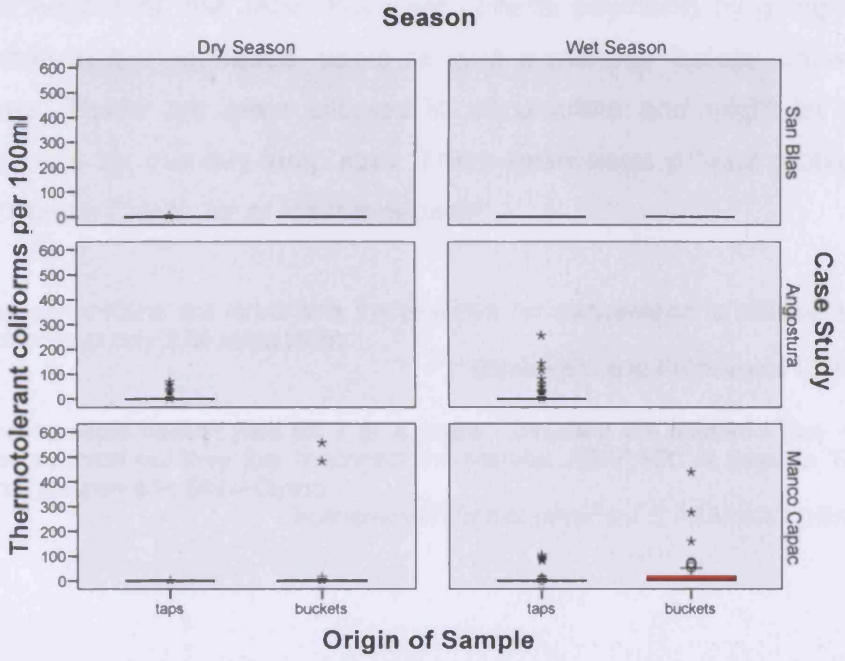
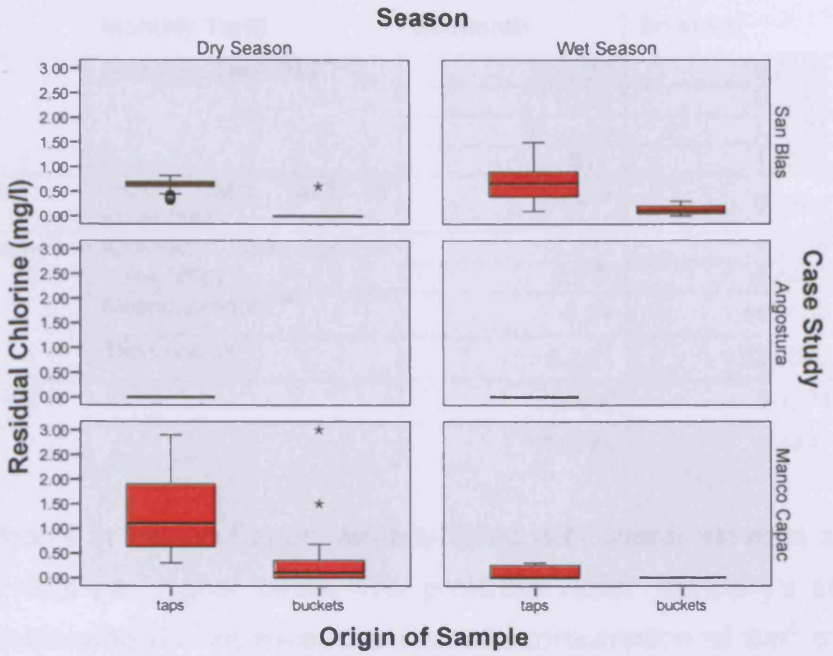


Figure 76 Box Plot showing residual chlorine readings



8.1.2.3 Affordability

Of the three case studies, San Blas is the only location with metering and billing. In Angostura, the JASS treasurer collects payments by going house to house while in Manco Capac, users receive a monthly "boleto" showing their water fees. These are often allowed to accumulate and might be paid, for example, as a six monthly lump sum. There have been serious problems with billing in Manco Capac for at least a decade:

> The connections are direct and the payment for consumption is minimal and symbolic at only 2.50 soles (43p)
>
> (Ministerio de la Presidencia 1998):8

> Some people haven't paid for 7 or 8 years - including the leaders - they are disconnected but they just reconnect themselves, ASAPASC is passive. This won't happen with SEDACusco.
>
> Interview with former president of ASAPASC (HH34)

Table 30Tariff comparison across case studies

Case	Monthly Tariff	m^3/month	Soles/m^3	£/m^3
San Blas	Domestic Tariff-012[142]	0 to 20	0.6302	0.1083
		21 to 30	0.8950	0.1538
		31 to 50	1.2101	0.2079
		51+	1.7521	0.3010
Angostura	JASS Fixed Tariff: 2 soles (34p)	12[143]	0.1581	0.0272
Manco Capac	ASAPASC Fixed Tariff: 5 soles (86p)	4.9[144]	1.0156	0.1745
		9.2[145]	0.5441	0.0935
	Molino vendors[146]	0.24	44.0000	7.5601
	Ttio vendors[147]	0.24[17]	63.0000	10.8247
SEDACusco's Social Tariff		*0 to 6*	*0.4034*	0.0693
		7 to 15	*0.7437*	0.1278

People in Manco Capac, already faced with poorer services and worse sanitary risks pay higher tariffs. The provincial water company's social tariff allows users who do not exceed a monthly consumption of $6m^3$ to pay just 0.4034 soles/m^3 (7p/m^3). For those that go over this amount the tariff rises to 0.7437soles/m^3 (13p/m^3). Notice that even the higher of these figures is less than the estimated cost by volume paid by the ASAPASC users.

We also saw in the livelihoods chapters that cash incomes in Manco Capac and Angostura were highly seasonal and often insecure which amplifies the tariff effect. Affordability is not just a question of absolute tariff level but also a function of cost relative to income. This comparison demonstrates that the water systems in these three case studies, with their differential service levels, present different risks to their respective populations.

8.1.3 Household assets: the interaction of vulnerability and infrastructure

In San Blas, the water service was directly linked to home-based enterprises in only two cases: the jeweller who used a little in production and the landlady who let rooms to international visitors and used water in adobe and cement for the ongoing expansion of her building. In Angostura, water was used

[142] This can be compared to the real cost of water production which is about 90centavos/m^3 (SEDACusco Interview 3 2006)
[143] Based on $63m^3$ per day for 147 households
[144] Based on 30 litres per person per day
[145] Based on 56 litres per person per day
[146] Based on 3 monthly trips, 5no. 16litre buckets and taxi ride at 2.50 soles and 20 cents per bucket
[147] Based on 3 monthly trips, 5no. 16litre buckets and taxi ride at 2.50 soles and 50 cents per bucket

for animals and gardens in all livelihood categories. Since the water service was continuous there was little need to resort to storage or alternative sources and when adobe making or other livelihood activities involving water (communal coriander washing) were observed, inhabitants were using brooks.

Water was linked to livelihoods in Manco Capac where it was used to patch up adobe houses, tend animals, top up taxi radiators, make chicha, street food and bread. With a water service that only operated on alternate days and for a few hours, households were resorting to water storage in just about any sort of container, buying water from the market, harvesting rainwater or borrowing it from neighbours, although this was not the case for the 'landlord' group where the households had a daily supply because they sat above a main water line.

Sanitary risk scores reflected household physical assets with the 'established' group in San Blas exposed to no or low risk and intermediate risks in the 'entrepreneurial' and 'excluded' groups, except where the Centro Guaman Poma de Ayala had intervened. In Angostura and Manco Capac, household sanitary risks were also low for those with the best physical assets.

All households in San Blas boiled water for drinking. In Angostura, although some households reported boiling water and reported water-related illnesses, households in the traditional and diversified groups used a mixture of boiled water and water direct from the tap. The adults said that children were especially likely to go straight to the taps. In the 'diversified' group, doubts over water quality were explicitly linked to the additional expense of having to boil it before consumption.

Manco Capac's householders also boiled water with several householders reporting water-related illnesses and a few expressing horror at the idea of drinking water straight from the tap. One shopowner with young children was even chlorinating her stored buckets of water with drops of household bleach.

In terms of general service provision, there was the sense in San Blas that central and tourist areas were prioritised by service providers with, for example, the nearest health services in the district of Wanchaq. In Angostura, too, the nearest health, education and police services were either in San Jeronimo or the district capital, Saylla. In this case, the settlement's small size constrained its access to decentralised government services. Infrastructure and

services in Manco Capac were poor with unreliable solid waste collection, unsealed roads, no storm water drainage and ad-hoc foul water drainage.

One household in the San Blas 'establishment' group expressed dismay at the fact that waste water ended up in the river but otherwise few aspects of infrastructure linked households in San Blas to natural capital beyond the barrio. By contrast, Angostura's vulnerability to flooding and contamination, the dependence on agriculture and the use of firewood as a fuel source all connected people to the environment. At the same time, there was no waste collection service at all, forcing inhabitants to dump their own rubbish into the river. Formally and informally the inhabitants were concerned about their own impact on the river and it was this community that had built a waste water treatment plant with the support of CGPdA. People were very aware of the plant and remembered a time before this infrastructure when their connections had discharged directly into the river or households had relied on latrines and open defecation.

This section describes the interaction of household vulnerability and infrastructure.

8.2 Buffering risk II: infrastructure and governance in the case studies

This section examines this interaction between infrastructure and governance, remembering that part of the participatory ideal promoted by the sustainable livelihoods framework has emerged in response to unequal access to influence and a failure to recognise of the needs of the least powerful. The challenge of participation is in engaging those for whom the access and aspiration to influence has been undermined by poverty (Ray 1998):252 (Wratten 1995):14 (World Bank 2006a):28.

To understand these relationships in Cusco, in this section, I use a socio-technical lens to look at the infrastructure systems serving the three case studies. Firstly, for each case study governance is broken down according to ownership and constitution of the provider, the social scale of the system (capacity of the provider to operate the system and engage users, strategies of users, external support) and technical scale (geographic reach, system components and production capacity, number of users and links to neighbouring systems and the environment). A summary table of the different provider organisations and their socio-technical scales is held in Appendix D5.

Secondly, these configurations of infrastructure are related back to broader questions of access to influence in each case study. As we saw in Chapter 4, Section 4.3 despite the high level, formalised performance of SEDACusco, the provincial water supplies do not cleave nicely into urban EPS provision and rural JASS provision: parallel administrations are still operating within the city and coexisting alongside breakaway municipalities that have pulled out of the provincial company.

Officially, the regulator SUNASS imposes sanctions on any registered EPS that fails to comply with its legal obligations. This means that the regulator does not play any role in overseeing parallel administrations or the JASS water committees which the Cusco SUNASS representative described as self-regulating or "auto-regulador" (SUNASS Interview 1 2006). Instead, the regulator is the key player in tariff-setting[148]. Public health is a matter for the regional health agency, DIGESA, which monitors water quality but has no enforcement powers.

7.2.1 The EPS: SEDACusco in San Blas

SEDACusco is a typical Peruvian provincial water company constituted by law as an Entidad Prestadora de Servicios de Saneamiento or EPS. The governance model follows one of ownership by the province's municipalities, each of which is a shareholder with shares divided according to the number of connections in each municipal jurisdiction. The elected mayors of each municipality sit on the board of the water company and act as the principal decision-makers. The industry regulator is the national watchdog SUNASS and public health monitoring is the responsibility of DIGESA, the regional health authority.

By law, the EPSs must self-finance and the emphasis is on cost-recovery through metering, charging and, where possible, private investment. Financial oversight remains centralized at the level of national government and for SEDACusco's CEO this is problematic:

> The Ministry for the Economy regulates us a lot in terms of administration and also in terms of audit. We are overseen by the General Controleria of the Republic and external auditors. In reality, the company works like a private

[148] Interestingly when tariff increases were announced in 2006, it was SUNASS that gave the press releases about price hikes rather than the local EPS.

> company but it is regulated, it is overseen, like a public service. This is a big flaw that hampers the development of many things in the company. It causes great inconvenience, many additional costs and reduces the decision-making power of the company that would otherwise certainly allow us better to manage and operate the water. It is very controversial because, for example, generating information for the state requires many additional man-hours. I would say nearly 30% of the year is taken up providing information to the state and we don't know where it goes or what it's for!
>
> 4mins (SEDACusco Interview 1 2006)

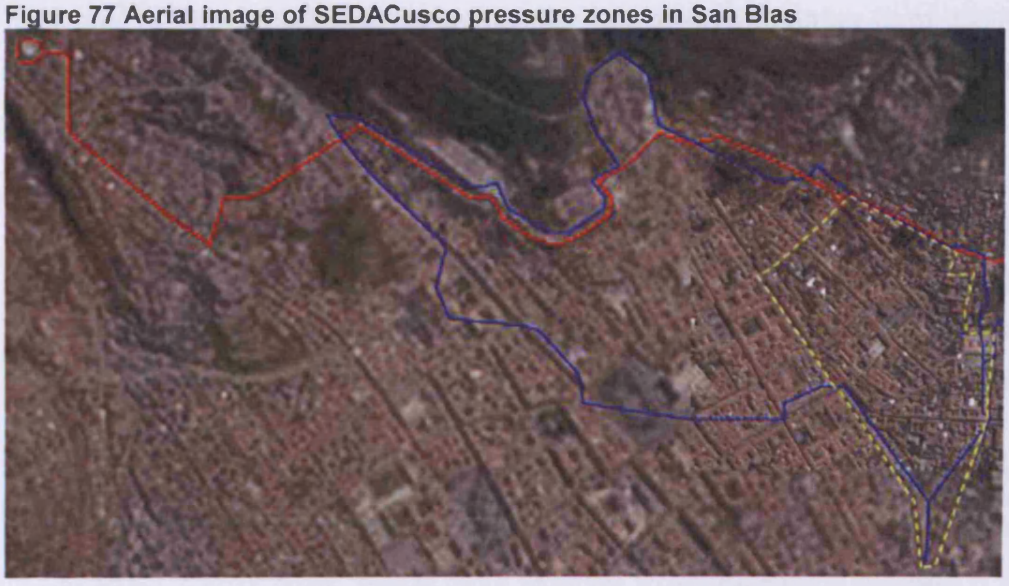
There is space in Peruvian legislation for private investment if the company can attract external finance. One current example is the phased, modular expansion of the waste water treatment plant at San Jeronimo. The feasibility study was conducted by a Japanese consulting firm and the project is to be funded by the Japanese Bank, JBIC (SEDACusco Interview 1 2006).

There is also engagement in the wider water community with SEDACusco providing and receiving training with other Peruvian EPSs, participating in IMA's Vilcanota Basin Management Committee and CGPdA's project for Integrated Water Resource Management, or GIHR.

San Blas counts itself in the north western sector of the city served by Lake Piuray. It is fed by the north main (Linea Norte de Aduccion) which is supplied from the Santa Ana treatment plant and reservoir. The satellite image in

Figure 77 shows San Blas outlined in yellow. It sits in the far eastern corner of the pressure zone allocated to it by SEDACusco, outlined in blue. The northern water main is shown in red tracing the contours of the valley's northern slope back to the Santa Ana reservoir in the west.

Figure 77 Aerial image of SEDACusco pressure zones in San Blas



Just over half of Cusco's water supply comes from Lake Piuray, a surface source 22km away from the city. In SEDACusco's simplified schematic in Figure 78, the lake, the treatment plant and the rough location of San Blas – between the northern main and the city's central plaza – have been highlighted simply to show their relative independence from other springs, reservoirs and boreholes.

Figure 78 A schematic produced by SEDACusco for the public (SEDACusco Interview 4 2006)

Treatment at the Santa Ana plant is in three classic stages: flocculation using aluminium sulphate in the rainy season and copper sulphate in the dry season; filtration through ten Degremot pressure filters[149]; disinfection with chloro gas to leave 1.2mg/l residual in the reservoir and 0.5mg/l in the network's final tap[150]. The 6,000cubic metre Santa Ana reservoir dates from 1970 and supplies four zones which are isolated, macro-metered and controlled from the reservoir outlet.

The system is not without problems however. First is the issue of water production and meeting demand. The yield from the lake is insufficient and water has to be rationed (SEDACusco Interview 2 2007). In response to population growth and this dwindling yield, SEDACusco brought the Vilcanota Project into operation and reduced the area of influence of the Piuray with an

[149] Filtration rate is 50-55l/s through graded sand (0.7mm top, 5-6mm bottom). The filter medium is replaced every 2 to 3 months and backwashing is carried out very 24 to 40 hours or when an indicator pressure of 25lbs/inch2 is reached. The cleaning cycle is 10 minutes with air, 10 minutes with water, 10 minutes with a mixture.
[150] Gas added at about 2kg/hr, 50kg in 24hrs. Minimum acceptable residual chlorine is 0.3mg/l.

emphasis on what their engineers call "sectorization" (SEDACusco Interview 4 2006). This production deficit disproportionately impacts the higher parts of the city:

> It's necessary to restrict water in the higher areas. The lower zones are the privileged ones.
>
> (SEDACusco Interview 4 2006)

There are also rather shocking system losses, estimated by the company to be 43% of production. Lastly, the city is seeing a growth in new multi-storey buildings on prime, central land. This is described as "crecimiento vertical" by the water company and puts additional pressure on central infrastructure (SEDACusco Interview 4 2006).

SEDACusco's system and procedures are sophisticated but on the basic criteria set out by the WHO, which are designed to highlight risk points for faecal contamination between the source and treatment plant in simple systems, the risk scores suggest an intermediate to high risk: SB1 in Figure 74. This is entirely due to the fact that Lake Piuray is a surface source in an inhabited, agricultural area. The sources feeding the lake are described as "showing a high level of bacterial contamination" (PRONAMACHCS & INRENA 2005)[151]. This result flags up the importance of a treatment plant that is carefully controlled, monitored and maintained. Figure 79 shows colour coded risk on the San Blas system inventory. Below is a reminder of the key.

[151] 66% of the samples from springs feeding the lake indicated low bacterial contamination: total coliforms between < 3 and 23 NMP/100 ml. and faecal coliforms between < 3 and 9 NMP/100 ml. The remaining 34% of samples present bacterial indicators of the order: total coliforms between 240 and 1,100 NMP/100 ml. and faecal coliforms from < 3 to 460 NMP/100ml. (PRONAMACHCS & INRENA 2005).

Table 31 Classification of thermotolerant coliform counts

TTC count	Colour Code
0	A
1 to 10	B
10 to 100	C
100 to 1000	D
>1000	E

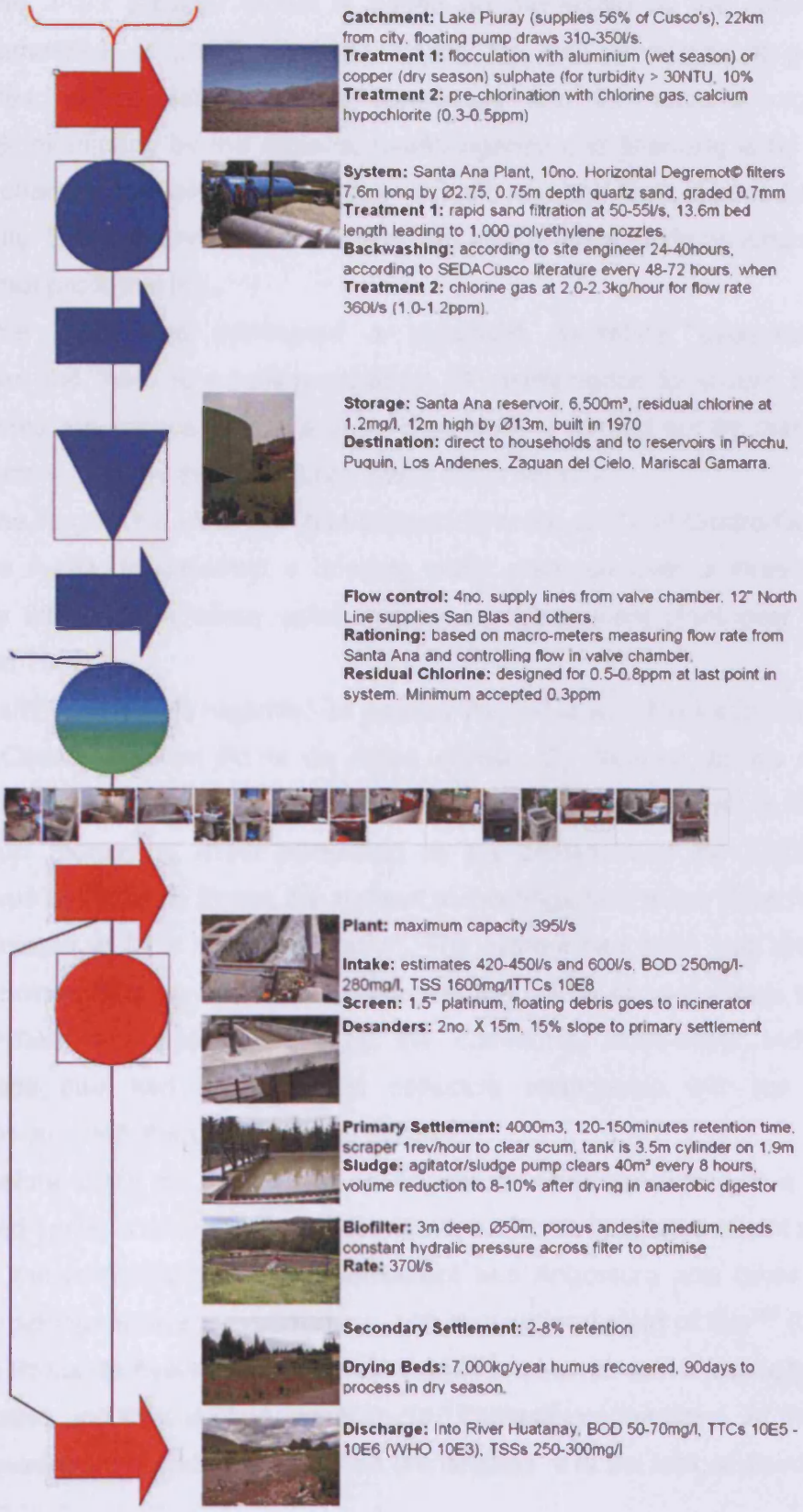
TTC = Thermotolerant Coliform
Adapted from Table 5.2 (World Health Organization 2006):78

Table 32 Flow chart symbols

Symbol	Definition of Symbol
	Operation: operations resulting in an intentional change in water
	Inspection: examination or test
	Storage: water is stored
	Transport: water is moved
	Combined activity

Adapted from Table 3.1 Process flow diagram symbols and WHO Water Safety Plan documentation (Davison et al. 2005;Davison & Deere 2006)

Figure 79 System inventory: San Blas



Catchment: Lake Piuray (supplies 56% of Cusco's), 22km from city, floating pump draws 310-350l/s.
Treatment 1: flocculation with aluminium (wet season) or copper (dry season) sulphate (for turbidity > 30NTU, 10%
Treatment 2: pre-chlorination with chlorine gas, calcium hypochlorite (0.3-0.5ppm)

System: Santa Ana Plant, 10no. Horizontal Degremot© filters 7.6m long by Ø2.75, 0.75m depth quartz sand, graded 0.7mm
Treatment 1: rapid sand filtration at 50-55l/s, 13.6m bed length leading to 1,000 polyethylene nozzles.
Backwashing: according to site engineer 24-40hours, according to SEDACusco literature every 48-72 hours, when
Treatment 2: chlorine gas at 2.0-2.3kg/hour for flow rate 360l/s (1.0-1.2ppm).

Storage: Santa Ana reservoir, 6,500m³, residual chlorine at 1.2mg/l, 12m high by Ø13m, built in 1970
Destination: direct to households and to reservoirs in Picchu, Puquin, Los Andenes, Zaguan del Cielo, Mariscal Gamarra.

Flow control: 4no. supply lines from valve chamber, 12" North Line supplies San Blas and others.
Rationing: based on macro-meters measuring flow rate from Santa Ana and controlling flow in valve chamber.
Residual Chlorine: designed for 0.5-0.8ppm at last point in system. Minimum accepted 0.3ppm

Plant: maximum capacity 395l/s

Intake: estimates 420-450l/s and 600l/s, BOD 250mg/l-280mg/l, TSS 1600mg/lTTCs 10E8
Screen: 1.5" platinum, floating debris goes to incinerator

Desanders: 2no. X 15m, 15% slope to primary settlement

Primary Settlement: 4000m3, 120-150minutes retention time, scraper 1rev/hour to clear scum, tank is 3.5m cylinder on 1.9m
Sludge: agitator/sludge pump clears 40m³ every 8 hours, volume reduction to 8-10% after drying in anaerobic digestor

Biofilter: 3m deep, Ø50m, porous andesite medium, needs constant hydralic pressure across filter to optimise
Rate: 370l/s

Secondary Settlement: 2-8% retention

Drying Beds: 7,000kg/year humus recovered, 90days to process in dry season.

Discharge: Into River Huatanay, BOD 50-70mg/l, TTCs 10E5 - 10E6 (WHO 10E3), TSSs 250-300mg/l

7.2.2 The JASS: Angostura's water committee

The JASS provider model is based on ownership by the community water committee or JASS, decision-making by the community at general assemblies, self-regulation by the community and the national regulator SUNASS, monitoring by the regional health agency and financing is by users through charges, the joining fee for new arrivals and any fines imposed on the community. External donors or financiers can also provide funds as long as the JASS is not profit-making.

The JASS has nominated a president, secretary, treasurer and technician and there is a rolling schedule of maintenance to ensure that all components are serviced twice a year. This work is carried out by *faenas*, or work teams formed by the community every three months.

The Angostura JASS has had support from the NGO, el Centro Guaman Poma de Ayala, to construct a drinking water reservoir over a three month period in 2001 and a waste water network and treatment plant over seven months in 2002.

Tariff collection is regarded as poor by the JASS with few people actually paying (Centro Guaman Poma de Ayala 2006b). By contrast, as we saw in Chapter 5, the attendance at assemblies and work days, or *faenas*, is high. In the annual monitoring sheet completed by the president of the JASS at a session run by Guaman Poma, the turnout at meetings held every three months was estimated at 80% of the population. The system had been built and was still maintained through these work days and the failure of households to take part resulted in a fine imposed by the community committee. Individual households thus had a direct and collective relationship with the water committee and with the upkeep of the system.

Before 2001, 80 households in Angostura were connected to a single gravity-fed spring source yielding 2.2l/s. Guaman Poma facilitated a joint project between the municipality and the settlement and Angostura now takes water from five springs above the settlement with a combined yield of 5l/s[152] (Centro Guaman Poma de Ayala 2006b). These supply a reservoir with a capacity of 62 cubic metres and then delivery water to 147 domestic connections. At the time of this research, the system still had no chlorination. It is the lack of disinfection

[152] At this workshop, the president of the JASS and one of his fontaneros completed a Ficha Annual de Seguimiento a los Sistemas de Agua y Desague. These data are taken from this form.

which pushes up the sanitary risk score although the thermotolerant coliform counts in the system – before reaching individual households – were negligible.

During one of the CGPdA workshops in 2006, the Angostura JASS identified several key problems including the lack of disinfection, old pipework and missing valves. The sanitary risk scores shown in Figure 74 place the system in the intermediate to high risk category and the presence of thermotolerant coliforms at different points in the system are colour coded onto the system inventory shown in Figure 83.

Figure 80 Angostura community session

Figure 81 Angostura community session: men participating

Figure 82 Angostura community session: women participating from a distance

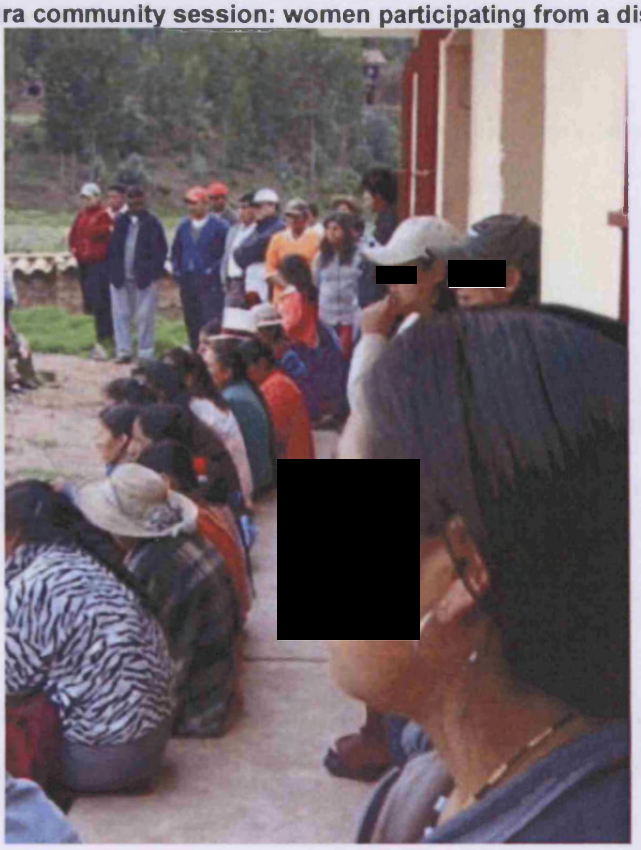


Figure 83 System inventory: Angostura

Catchment: 5 spring sources in surrounding hills, total 5 l/s (before 2001 2.2l/s)
Distribution: gravity feed

Primary Storage: 62m³, opened in July 2001 (before 2001 no reservoir), 3 months to construct and funded by the APV and the municipality.
Maintenance: work teams to maintain the system 4 times per year. Cleaning of components every 6 months

Distribution: gravity-fed through 3,000m of pipes

Household service: 147 connections (before 2001 this was 80 connections)

Plant: 180 household connections, 4,200m of pipework, opened in 2002, 7 months to construct and funded by Guaman Poma de Ayala and the Municipality (before 2002 no wastwater system)

Wastewater Treatment: primary settlement only, intake grill broken, sluice cannot be closed properly.
Maintenance: inadequate cleaning and maintenance, no personnel because they cannot be paid.

Discharge: River Huatanay

7.2.3 The Hybrid: ASAPASC in Manco Capac 'chocolatada'

> Each man had to go with his shovel, his pick, sand, cement. That's how it was. We brought [water here] by making so many sacrifices.
>
> Household 41, Manco Capac

This quote echoes many of the comments from people interviewed on the Right Bank when they describe the toil of bringing water to their settlements. The construction took place between 1985 and 1990 with inhabitants volunteering their time to build the infrastructure. These days, Manco Capac shares its water provider, ASAPASC, with sixteen other barrios on the Right Bank of the River Huatanay (SedaCusco 2007b).

The provider model – according to the written constitution – is a slightly expanded version of the JASS, described in the previous section with ownership by the committee, ASAPASC, decision-making by the community at General Assemblies, self-regulation, monitoring by DIGESA and health posts and financing by users and donations. Like the JASS, ASAPASC is funded from user fees, connection fees and fines and there has been NGO funding in the past.

The legal status of ASAPASC remains ambiguous, however, since the General Water Law tells us that if the JASS serves more than 2,000 inhabitants[153] and is not in a area that has been classified as rural, then urban rules apply. In other words, the association should be dissolved and the system subsumed into the appropriate EPS. With ASAPASC, the system falls outside both the rural and urban remit of SUNASS and thus has no formal regulation. The regional health authority still has monitoring responsibilities but this time it cannot call on SUNASS for legal sanctions.

In terms of system data, all that was available in the administration office was a poor reproduction of an undated and unauthored map. According to the administrator this plan was drawn up in 1992 but in the same interview it was explained:

> ...the maintenance team do not need to use a plan because they know the system...
>
> (ASAPASC Interview 1 2006)

[153] Chapter 10, Article 47

ASAPASC claim that there is a programme to monitor water quality with samples taken by the provider four times a year and processed at SEDACusco's laboratories. The administrator was very vague about sampling: apparently samples are taken from within dwellings although ASAPASC does not guarantee quality once water has entered the domestic installations.

Originally, the system was supported by an external NGO. Now World Vision is wary of intervening while the community is torn over who should be managing their water. CGPdA is also reluctant to intervene because they do not want to deal with ASPASC.

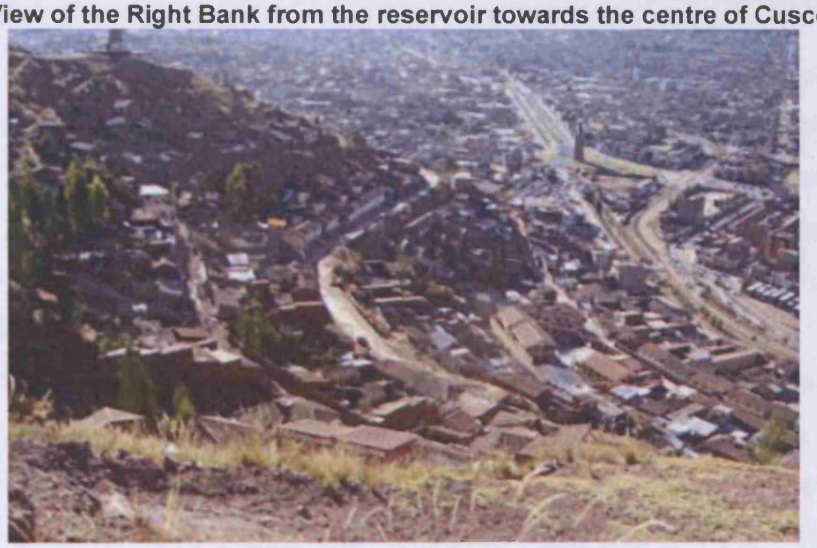
ASAPASC's constitution states [154] that any official member of the settlement – where a member is one person nominated per connected household – is not only obliged to vote in General Assemblies but should also be prepared to stand for office on the executive board or another committee (Notaria de los Rios Guzman 2001). However, according to the household interviews, members of ASAPASC's board vote amongst themselves for executive positions. The executive members explained that each neighbourhood puts forward a representative to sit on the board (ASAPASC Meeting 2006).

There are two sources used by these communities. Both sources used by the sixteen settlements on the Right Bank lie 9km away in a campesina community called Collorpujio. The 6inch and 4inch mains have been plotted in a solid red line on the image below. The households which have managed to tap into the main water line and receive a twice daily service live parallel to this line. Two such households are in the Landlord Livelihood group described in Chapter 6. Note also the gradient which is not immediately obvious from the satellite images: there is a 100m height difference between the main road and the Chocco Reservoir.

[154] Chapter 2, Article 10.B

Figure 84 Aerial image of Manco Capac distribution system

Figure 85 View of the Right Bank from the reservoir towards the centre of Cusco



The collected settlements on the Right Bank have been granted a Ministry of Agriculture permit to use 25l/s (or 777,000m^3) of water per year (Ministerio de la Presidencia 1998) but the Ministry of the Presidency noted in 1998:

> ...because of excessive population growth this limited water resource cannot supply sufficient water.
>
> (Ministerio de la Presidencia 1998):7

According to ASAPASC the yield was 25 l/s in 1985. The Ministry of the Presidency reported 18l/s in 1998 and ASAPASC report that it is now only 15 l/s and the former president explained that:

> There isn't enough water [at source]. We as users are not aware. In people's houses, the taps are broken and this affects the other users.
>
> Former president of ASAPASC (HH34)

SEDACusco calculate an even lower yield this in their study, estimating an average annual figure of only 14l/s (12l/s in the dry season and 16l/s in the wet season). In addition to this fall in yield, SEDACusco's study found that none of the nine air valves along the 9km of line from source to plant were working. One important risk factor at the source is agricultural activity in the catchment:

> Agreements need to be established with the community of Coyllorpujio, located above the source, to establish mechanisms for the management of water in terms of time periods, volumes and the rational use of chemicals higher up.
>
> (SedaCusco 2007b)

Of the 8 purge valves, only 5 were working and all were judged to be in an "estado pesimo", or a terrible condition (SedaCusco 2007b):12. The ASAPASC committee admitted that maintenance and renovation of this pipework could now not be done by the community alone. The existing asbestos-cement pipes were originally donated by a foreign NGO and their 30 year life design life is rapidly coming to an end.

In terms of treatment there is a filtration plant before the main Chocco Reservoir. On my first visit at the end of June 2006, both filter beds had been completely bypassed while they were emptied for maintenance. The supply was untreated and the maintenance team explained that this level of cleaning was done every two years although it was dependent on cash flow and no planned maintenance schedule existed. SEDACusco's survey found that there was a fortnightly cleaning regime but the ASAPASC documentation to back this up could not be made available to me.

From here the supply destined for Manco Capac and subsequent barrios went to a 500 cubic metre reservoir above Chocco.

Figure 86 View of the Right Bank from the reservoir towards the south and the airport (runway in middle distance)

The ASAPASC administrator explained that July was the last month when the reservoir would be completely full until the rains began again in November and December. The reservoir was cleaned every 2 to 3 months but, again, there was no written record of this or plan for future maintenance. Chlorination is by chlorogas canisters, via an electric pump that the maintenance team operates manually. It is allowed to run for a couple of hours before the contents of the reservoir are released into the network at about 5.30am. This was one of the few processes for which ASAPASC claimed there was documentation kept on site at the reservoir where the fontaneros recorded the results of a colour test. In fact, the team could not produce this. Residual chlorine in the system was variable and the ASAPASC administrator himself admitted that chlorination was unpredictable because the *fontaneros* were asleep or drunk!(ASAPASC Interview 1 2006).

Interviews with doctors at the health post in Manco Capac suggested that ASAPASC's self-regulation, particularly in terms of water quality, was poor. The water samples taken by ASAPASC and sent to SEDACusco's laboratory were often of unknown provenance. The despairing local doctor explained:

> All the Ministry of Health can do is warn people that the water is poor quality...
> (Centro de Salud Manco Capac 2006)

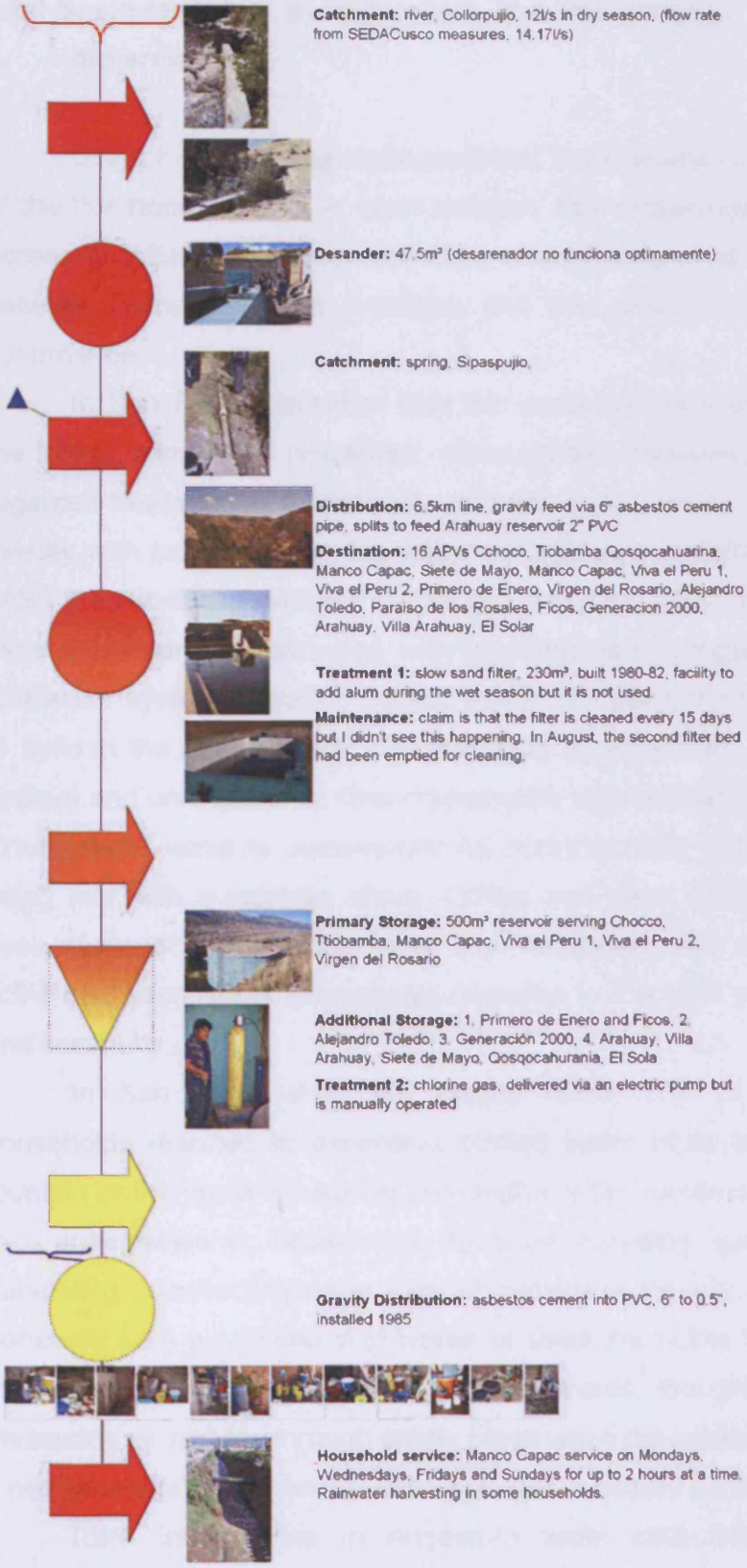
SEDACusco's analysis confirms inadequate post-treatment disinfection, lack of network drawings and inadequate maintenance as major weaknesses in ASAPASC's system. After modelling with WaterCAD, SEDACusco noted that:

> ...the pressures in the system vary substantially because of the considerable difference in static pressure that exists in the nodes that make up the distribution system, as well as the lack of regulating valves, all of which results in the poor operation of the network
>
> (SedaCusco 2007b)

SEDACusco's engineers also flagged up the miserable condition of individual household connections and the absence of metering.

Sanitary risk scores have been assessed for both the spring (MC1) and surface (MC2) sources and are shown in Figure 74. The TTC counts are also incorporated into the flow chart in Figure 85 to illustrate contamination at different points in the system.

Figure 87 System inventory Manco Capac



Catchment: river, Collorpujio, 12l/s in dry season, (flow rate from SEDACusco measures, 14.17l/s)

Desander: 47.5m³ (desarenador no funciona optimamente)

Catchment: spring, Sipaspujio,

Distribution: 6.5km line, gravity feed via 6" asbestos cement pipe, splits to feed Arahuay reservoir 2" PVC

Destination: 16 APVs Cchoco, Tiobamba Qosqocahuarina, Manco Capac, Siete de Mayo, Manco Capac, Viva el Peru 1, Viva el Peru 2, Primero de Enero, Virgen del Rosario, Alejandro Toledo, Paraiso de los Rosales, Ficos, Generacion 2000, Arahuay, Villa Arahuay, El Solar

Treatment 1: slow sand filter, 230m³, built 1980-82, facility to add alum during the wet season but it is not used.

Maintenance: claim is that the filter is cleaned every 15 days but I didn't see this happening. In August, the second filter bed had been emptied for cleaning.

Primary Storage: 500m³ reservoir serving Chocco, Ttiobamba, Manco Capac, Viva el Peru 1, Viva el Peru 2, Virgen del Rosario

Additional Storage: 1. Primero de Enero and Ficos, 2. Alejandro Toledo, 3. Generación 2000, 4. Arahuay, Villa Arahuay, Siete de Mayo, Qosqocahurania, El Sola

Treatment 2: chlorine gas, delivered via an electric pump but is manually operated

Gravity Distribution: asbestos cement into PVC, 6" to 0.5", installed 1985

Household service: Manco Capac service on Mondays, Wednesdays, Fridays and Sundays for up to 2 hours at a time. Rainwater harvesting in some households.

8.2.1 Socio-technical configuration: the interaction of infrastructure and governance

Using the preceding socio-technical analysis and returning to the results of the livelihood surveys in each location, this section explores differences in access to influence between the case studies, beginning with the relationship between users and water providers and then moving on to look at broader governance.

In San Blas, interaction with the water company was through billing or the formal complaints procedure, although the 'entrepreneurs' and 'excluded' regarded this latter as fruitless. By contrast, in Angostura, users communicated directly with individuals on the water committee, the maintenance person, the JASS president and even the settlement president. Their regular work days and assemblies were well attended, with fines imposed on those who failed to come. The water system in Manco Capac, which had taken the community five years to build in the late eighties, was managed by ASAPASC, widely regarded as opaque and unresponsive. One householder reported taking in glassfuls of their 'chocolatada' water to demonstrate its murky turbidity to the administrator and being met with a helpless shrug. Others had given up complaining and had even stopped paying. Apart from the 'landlords', one of whom sat on the ASAPASC committee, households objected to the cost on grounds of quality and continuity.

In San Blas, when the supply failed, one of the 'establishment' households resorted to expensive bottled water while others used a public fountain or the brewery's spring (although not for human consumption). Among the 'entrepreneurs', households reported recycling grey water, rainwater harvesting or collecting water from elsewhere in the city, while the 'excluded' borrowed from a neighbouring hostel or used the public fountain. Costs were regarded as high, either because households thought that meters were measuring air rushing through empty pipes when the system was off or because it was poor quality and known to be cheaper in nearby parallel administrations.

Rare interruptions in Angostura were attributed matter-of-factly by householders to maintenance events: users knew about these because they were involved in the repairs. Not only was the cost regarded as low in most

cases but interviewees expressed the view that they were obliged to pay and work together to make the system better. The only objection came from a tenant who felt that the fact the community worked on the system should mean it was cheaper. Later it turned out that while tenants were expected to participate in the work, it was the landlords that held the voting power at the assemblies.

With water supplies more often off than on, residents in Manco Capac resorted to buying water from vendors with taps connected to the SEDACusco supply, harvesting rainwater and borrowing water from neighbours. Opinions were mixed on the entry of SEDACusco, the provincial water company with some fed up with the poor service and others afraid of a costly, metered supply. SEDACusco was negotiating adoption with ASAPASC on the assumption that this committee was the best representative of the community. This was not helping to build confidence or strong communication between the potential provider, SEDACusco, and users. Attitudes to ASAPASC ranged from despondency to suspicion, users were alienated from it and communication between the provider and the users was poor even though people were having to deal with very poor levels of service.

The formal and anonymous relationship with SEDACusco meant that individual households in San Blas were connected to this institution rather than engaging within the neighbourhood on water and sanitation. Instead San Blas' institutions included the neighbourhood committee, regarded as a closed circle of privileged and longstanding residents, the external interventions of the NGO Centro Guaman Poma de Ayala (CGPdA) and home-grown community-based organisations. Residents had also resorted to private sector security to protect their property, although the 'excluded' had opted out of paying for this service.

CGPdA was upgrading household infrastructure connections and supporting repairs and improvements to older houses. They were also building capacity for collective action and promoting home-based enterprise, targeting households with the most precarious livelihoods by fully or partially subsidising the network connections for the 'excluded' and some 'entrepreneurs'. CGPdA's research and knowledge of the area as well as ongoing engagement with individual households meant that they were able to distinguish between household livelihoods and target accordingly.

The home-grown NGOs seemed to have been set up by householders that were either not beneficiaries of CGPdA or had expressed low expectations

of the state. The focus was on enterprise development, dealing with a particular cause or sector (other than water infrastructure), for example rehabilitating the cultural centre or training artisans. These activities straddled governance categories of civil society and market and highlighted the fact that the priorities had moved on from collective infrastructure.

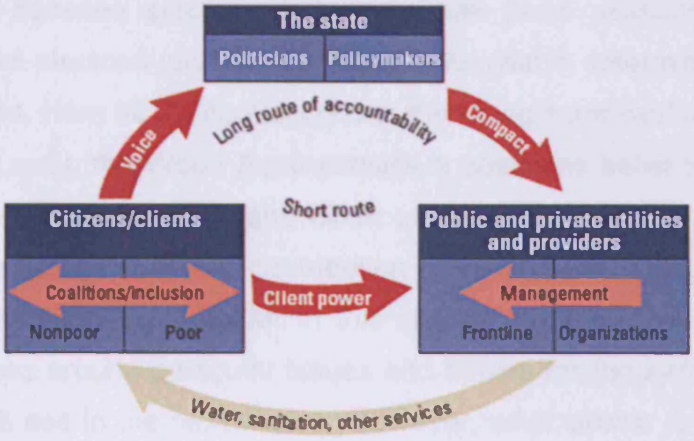
By contrast, much of Angostura's neighbourhood interaction was based around the water infrastructure. The settlement committee had built strong engagement partly by imposing fines on households that failed to participate and collective activities to maintain the water system and prevent flood damage. At the level of the municipality, although people felt neglected by the lack of waste collection services, the municipality's efforts in building flood defences and assisting after floods were recognised. The settlement committee in Angostura was also linked politically to the municipality through the settlement's president, a new arrival to the area with a professional livelihood who had already secured election as a local alderwoman. The Mayor of Saylla District was then linked in to regional level initiatives to orchestrate social development and integrate resource management, facilitated by CGPdA. Admittedly, awareness of these larger scale activities among the population of Angostura seemed to be limited, even though formal governance structures were in place or emerging.

Apart from the important support of CGPdA in the construction of the reservoir, the waste water treatment plant and the networks for water and waste, NGO activity was not particularly co-ordinated (random training on homebirths and rearing small animals, and the installation of WCs in the school by one NGO).

In Manco Capac, what had been intense collective action on water provision had become a disillusioned relationship with the provider. Collective action had become confined to road repairs by housing block committees although even here participation was variable. Where it was strong the physical infrastructure was visibly better with roads and pavements built by the communities working together in their own time. Many households had livelihoods outside the neighbourhood and a lack of confidence in their local committees meant that co-ordination of activities at the Manco Capac settlement level was non-existent and attendance at settlement level assemblies and meetings was low. This atmosphere had also deterred the entry

of NGOs. In addition, the perception was that the municipality was not serving Manco Capac, especially in terms of waste collection services. For its part, the municipality regarded Manco Capac as part of a zone in arrears on local taxation and this meant municipal engagement was weak and unstructured.

In summary, what we have across the case studies are different paths to influence, some more direct than others. It is useful here to look at these relationships in light of the World Bank's triangle of governance.



Theoretically, across Cusco people are linked to central and municipal government as individuals compelled to vote in Peru's elections. This constitutes part of the voice relationship between citizens and the state which can also be supplemented by other civil society activity.

In San Blas, municipal elections are relevant to water and sanitation because the provincial water authority is governed collectively by the mayors of each municipality. Households are then linked by 'client power' to the water provider through billing, according to consumption and the possibility of making individual complaints. Other paths to influence, for the 'establishment', are through the neighbourhood committee and, for the 'excluded', the NGO Centro Guaman Poma de Ayala.

Angostura's situation is different in that access to influence over water is direct and via collective work days and assemblies. The community is also the provider, contributing labour and materials as well as voting on decisions. The community water committee is visible and accountable to the population and to the committee president. Fees are nominal and the same for all households but financial sanctions are imposed on those who do not participate. Voice directed to the state in between elections is more convoluted with the settlement president meeting the district's mayor and the mayor meeting other mayors in

between elections. More importantly, for these small, outlying municipalities the 'compact' relationship between the state and the provider is more ad hoc with small budgets limiting the reach of services.

In Manco Capac, the relationship between individual users and the provider committee has broken down and there is no relationship between individuals and SEDACusco the provincial water company. Collective action is also weak and although the mayor of Santiago is elected by people in Manco Capac, between elections it is the weak fiscal relationship rather than the individual electoral relationship that is influential in determining how services are delivered. Here all the connections in the triangle are dysfunctional.

Lastly, the World Bank considers coalitions between the poor and non-poor to be part of voice and client power. This can also be seen in terms of urban heterogeneity, the contribution of which to buffering collective risks has been seen positively so far in this chapter. In the ideal triangle, civil society coalesces around particular issues and strives for the inclusion of all users. As we shall see in the next section, however, what seems to be happening to the triangle in this context is that these social coalitions do not reach outside the technical infrastructures which users share. For example, people outside the provincial system have no voice connection to the municipalities governing the system, no client power relationship with the provider, no formal dialogue with the provincial system's users and yet must deal with the environmental consequences of the user's waste water and the provider's lax waste treatment.

8.3 Socio-technical systems mediating vulnerability in San Blas, Angostura and Manco Capac

The worst performing system in terms of quality, quantity, continuity and accessibility was Manco Capac's, with San Blas and Angostura each with their own strengths and weaknesses in terms of these indicators.

The first observation to make on access to infrastructure is that quality, quantity, continuity and accessibility were ranked higher where those with weak assets shared this infrastructure with households with strong assets and, in San Blas, international tourists. In Manco Capac, homogeneity in vulnerability contributed to an inability to buffer collective risks like poor infrastructure and torrential run-off. The groups of households with the weakest asset bases were the least able to buffer the risks that their poor collective infrastructure threw at

them. This links back to the residential segregation identified by Batley, Montgomery et al. and McAslan and, as we will see in Chapter 9, this can be seen as part of the tendency for investment to privilege or bypass certain groups, often based on perception of livelihoods. In this regard, Batley also made the point that urban economic winners act when the amenity value of the city deters investors or, in the case of San Blas, might deter tourists.

Secondly, poor water provision was amplifying the vulnerability of livelihoods. This is most obvious in Manco Capac where several households with poor sanitary risk scores and with the worst continuity of service were either using poor quality water or expensive supplementary sources for home-based enterprises like bread and food production, chicha and mixing construction materials. This echoes the comparison of affordability that shows the extra burden on household budgets of having to supplement inadequate water services. The assertion that those with the worst services pay a premium for their water, made so clearly in Independent Water Providers in Latin America (Solo 2003):5, also seems to hold in Manco Capac.

Thirdly, the observed vulnerability of these households to environmental risks reflects several of the comments cited in Chapter 2 that point out that the world's poorest actually make the least impact on stocks of natural capital but are potentially the worst affected by its depletion (Newman 2006):280; (Hardoy et al. 2005):346; (McGranahan et al. 1999):108. This is particularly true for Angostura, at the edge of the city, with its simultaneous dependence on agriculture and exposure to hazards. Although the population made collective efforts to reduce their own impact through hardware – this settlement had its own waste water treatment plant – and local institutions, in reality their environmental risks can only be mitigated through institutional links back to the centre of Cusco.

Finally, livelihood vulnerability is also amplified though the household experience of a range of other services, not just water and sanitation. In particular, this seems to apply to municipal provision of waste collection, works on pavements and sealing roads and policing or security. In San Blas, for example, the relative strength and heterogeneity of household assets coincided with better access to collective infrastructure like sealed roads, waste collection and predictable water services. Unfortunately for Angostura, these features also

insulated households from exposure to environmental risks and awareness of their environmental impact.

This idea of differentiated service provision comes up in discussions over private sector provision of water in the work of Ana Hardoy, Marvin and Laurie and Bas van Vliet et al. For Hardoy, and to some extent Marvin and Laurie, faced with monolithic concessions that cannot accommodate the needs of low income urban settlements, a differentiated offering is appealing because it suggests that services can be tailored so that the worst off can choose a service package that suits their livelihood. In the work of van Vliet et al. differentiation is part of a highly sophisticated provision model that adapts networked services to the highly differentiated demands of users: in this case tailored to lifestyle. My research suggests, however, that differentiated services in Manco Capac, for example, serve to amplify vulnerability. The interaction of livelihoods and infrastructure has, therefore, to be carefully understood before differentiated services move from being the observation of a phenomenon to a policy prescription that builds configurations of infrastructure that entrench and undermine livelihoods.

Lastly, relating these configurations back to Robert Chambers' vision of diversity and complexity in urban livelihoods, the situation in Cusco has three complicating factors. Firstly, diversity was not evenly distributed within households or across the city. It was also possible for the vulnerability of a single household to be more homogeneous in some cases, with all adults in a household vulnerable to similar shocks and stresses. In San Blas, however, where livelihoods were heterogeneous, collective water, sanitation and surface water infrastructure was better at buffering common risks. Notwithstanding a context of highly individualised relationships with service providers and government, it was also possible for 'excluded', vulnerable livelihoods in San Blas to exist alongside active neighbourhood committees which went on serving the 'establishment'. This highlights the fine line between heterogeneity per se – which could also be read as development-constraining inequality of the sort described, for example, by the World Bank and Ellen Wratten – and heterogeneity in vulnerability which sees diversity as positive because it means that not everyone will be knocked by the same problems at the same time.

Secondly, the success of diversity depends on households in the same neighbourhoods being exposed to risks which are idiosyncratic or independent

of each other. In fact, seasonal, local and global vulnerabilities are interrelated. More crucial to this study, the risks presented by splintering configurations of water and sanitation infrastructure interact not only with household livelihoods but also with the other services and modes of governance often compounding vulnerability especially where it is already homogeneous. One result of this in Cusco is that the mechanisms that privilege investment in infrastructure are strongly linked to SEDACusco's perception of the risks associated with dealing with certain sectors of the city: their livelihoods, existing configurations of infrastructure and potentially awkward activism.

On the basis of the empirical evidence from the case studies, I argue in this chapter that sanitary risks are differentiated by household – those with weak physical assets, like poor patio drainage, are exposed to higher risks. I then explain, with reference to the WHO's risk assessment framework and indicators of quality, quantity, continuity, accessibility, that differentiated services – not just household assets – are amplifying sanitary risks for those least able to buffer them. This, I argue, shows that household vulnerability is mediated by the socio-technical configuration of entire systems for water and sanitation. Finally, by returning to the livelihoods analysis that uncovered the household and collective relationship to the provision of other services, I begin the argument that these modes of organisation follow similar socio-technical patterns that differentiate between groups and households and mediate vulnerability. In the next chapter, I expand on this argument and look socio-technical systems as they stretch beyond the case studies to the rest of the city.

Chapter 9 Socio-technical systems mediating between vulnerability and governance across Cusco

9.1 Distilling the dynamics of mediation: privilege, bypass, resistance and networking

In this penultimate chapter, I turn the socio-technical lens to the broader context of governance in the case studies and in Cusco at large. This forms the final part of my response to the research question by looking at the relationship between governance and the mediating role of socio-technical systems in mitigating risk. I look at the origins of water governance in Peru and frame it in the broader context of global trends in water governance. I revisit the divergence between policy and needs based provision and make an analogy between this split and the mediation between governance and livelihoods that has given rise to the modes of organisation that are operating in Cusco. Then, by looking at the patterns of connection and disconnection across the city and invoking the notion of splintering, I argue that socio-technical systems conspire to shape the city through processes of privilege, bypass, local resistance, both staying out and breaking away from the provincial system, and networking between socio-technical scales.

Finally, I place the socio-technical systems in Cusco into the conceptual space developed in Chapter 2, bringing this chapter to a close with a review of this model in light of the empirical evidence from Cusco.

9.2 Messy modes of organisation: revisiting the roots of Peruvian water governance

We saw in Chapter 2 that the decentralisation of Peruvian water provision paralleled the nation's devolution of power to its regions and took place against a political backdrop that had for a long time maintained the coexistence of centralization and a popular brand of participation or authoritarianism and populism (Hordijk). Although this promoted the direct participation of beneficiaries in their own services on one hand (World Bank 2006), it overlaid a history of central government interference in urban social movements and cultivated an adversarial relationship between community organisations and entrenched political interests in the regions.

Peru's chosen model for urban water provision was then built within a framework of municipal ownership, central government regulation and commercialisation of operations that could accommodate private investment

and public-private participation later on. The emergence of this model tracked the rhetoric of good governance and the World Bank's early emphasis on private sector participation. As we saw in Chapter 2, this was part of a wave of reform in the early nineties that was driven internationally through Lima and which cemented three strands of governance in Peruvian legislation.

The first imperative was to commercialise water provision; a move designed to improve efficiency and cost recovery from users and to open the door to private investment. This had to satisfy the lending criteria of international financial markets as they sought out entities and locations to put their capital on the basis of risk and return: indicators which ratchet helically upwards as perceived risks nudge up required returns (Collier 2007):89.

The second element of governance was a municipal ownership structure, which in practice helped to consolidate the power of the best connected by apportioning shares according to the number of existing connections. At the same time, this has also created useful and important direct link to local structures of governance.

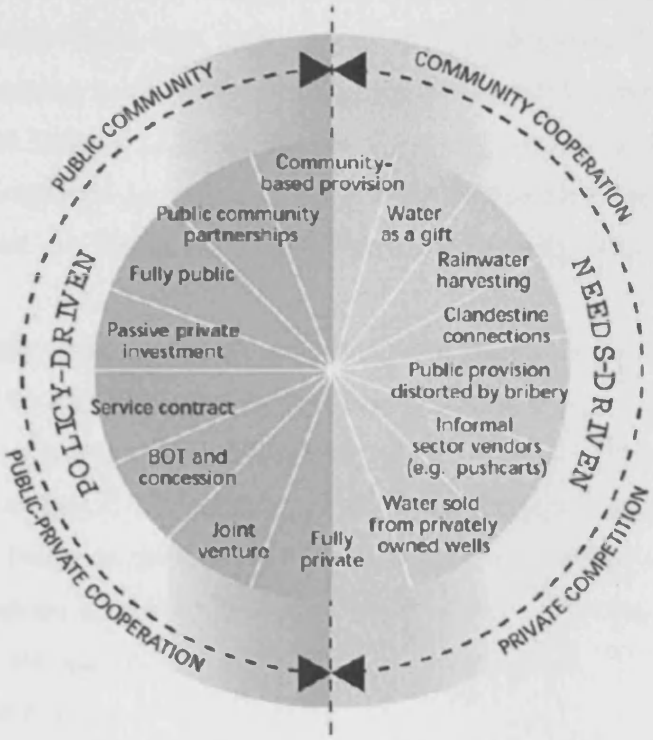
The final strand of the legislation was designed to convey the unsubsidised, 'true' economic cost of water to users through infrastructure as one way of communicating the finite nature of fresh water resources and sustaining natural capital. This fits into the story of global environmental governance and sustainable development.

Meanwhile, in Cusco, defying the nicely organised national framework that governs drinking water provision, we find coexisting models. With the election of Daniel Estrada in the mid-eighties, efforts began to improve basic services in Cusco. In the face of a deepening inflationary crisis, these efforts would never be enough to universalise provision and, even with the reforms of the early nineties, self-regulated, urban water systems persist until now and continue to fall between the provincial, regulated EPSs governance model and the rural JASS framework. In addition, a weak water sector regulator, SUNASS, and limited regional capacity for environmental and health monitoring in DIGESA, mean that services in Cusco are highly variable.

Alongside the provincial water company, in Cusco we find dysfunctional urban water committees, like Manco Capac's ASAPASC. In the province's outlying municipalities, which begin at Saylla, we find the newly formed Angostura JASS.

In terms of provider governance, all these modes can be seen in the DPU's wheel of peri-urban water governance. The first explicit addition would be SEDACusco's EPS governance model which, as we have seen, organises public ownership according to municipal shareholdings and which spans the slices of passive private investment (private finance, for example from the Japanese), fully public (fragmented municipal ownership) and public community partnerships (negotiated social tariffs).

Figure 88 The DPU Circle: from a 2005 unpublished paper by Adriana Allen (Allen et al. 2006):339



The second addition to the DPU wheel is a more detailed picture of community-based provision. As anticipated by Chapter 2, what became apparent in this research was the ambiguity of the term 'community'. I argue, for example, that the momentum of community organisations tends to decay once the urgent collective action to meet basic needs has subsided. Indeed, this was one of the issues thrown up the slum dwellers federation in their attempts to institutionalise charismatic community leadership for sustainable management of their unorthodox models of co-provision in India.

The experience of civil society actors working closely with community organisations in Cusco suggests that the drivers for popular organisation and

protest may start out as a basis for making claims but then become a platform for local power consolidation. This can mean that hierarchies in local committees eventually lose their capacity to engage or promote local participation, sometimes excluding the marginalised and leaving holes in accountability which, in Manco Capac, have allowed community assets to be run down or exploited. Diana Mitlin suggests as much, writing generally on civil society (Mitlin 2001):157. In Manco Capac, this state of affairs fed back into and was compounded by weak household assets, homogeneous, simultaneous and highly interlinked, vulnerabilities, deteriorating infrastructure and dysfunctional paths to influence.

The Cusco case studies suggest that where collaboration between users, providers and government has been successful in Angostura, this has only been possible because participation has been supported by civil society in the guise of the NGO Centro Guaman Poma de Ayala. Similarly, Manco Capac, adrift from NGO intervention because of its own internal tensions, can probably best be described in Hardoy's terms as a community that has "difficulty organising".

More broadly, though, the absence of participation is partly explained by a lack of policies to support community-managed systems, as Bustamente et al.'s lamented in Chapter 2 (Bustamente et al. 2004). This policy gap is reinforced by the tendency to undervalue the "non-monetary contributions" that community users make to their systems and in fact this analysis matches very closely the experience of Manco Capac in terms of the pride and value that has been historically placed on the settlement's infrastructure and the provincial provider's disregard of this.

Despite the reservations of CGPdA about the capacity of communities, shared incidentally even more vehemently by the provincial water company SEDACusco, only CGPdA is providing any substantial support to community-managed systems. This support comes with the two important caveats that it is delivered at the point at which the community (committee and users) is ready to engage with their municipality and when there are systems are in place to strengthen municipal capacity.

This policy has manifested itself in the north-eastern zone as CGPdA helping to negotiate social tariffs, which SEDACusco adopted the community built infrastructure in the early nineties and continues today with advice and

material support as the community finds itself having to maintain the water sources that are theoretically managed by SEDACusco.

In peri-urban Angostura, where there is no prospect of adoption by assistance from SEDACusco, CGPdA's support includes facilitation of inter-district institutions for integrated water management; training for JASS maintenance staff and municipal technicians; and the construction of drinking water and waste water infrastructure.

In San Blas, where residents are long-standing SEDACusco users, CGPdA's sanitation upgrades targeted according to livelihood with subsidies to the most precarious and 'excluded' inhabitants, partial support to 'entrepreneurs' and more secure, 'establishment' households given technical but no financial help.

What emerges from these three examples of successful civil society intervention is that addressing Bustamente et al.'s policy gap is a question of recognising paths to influence (north-eastern sector and Angostura), existing configurations of infrastructure (Angostura) *and* livelihoods (San Blas).

These successes need not be the exclusive domain of civil society, however, and, after Hardoy et al., the "sole actions" of any one player in the governance framework are unlikely to resolve the differentiated household experience of risk brought about by messy access to influence, splintered infrastructure and compound vulnerabilities. The capacity to deal with these three interacting issues has to be enhanced for all actors to improve the prospects for sustainable livelihoods that do not damage the livelihoods of others.

What the DPU circle exposes is that even the best laid plans for policy-driven water governance cannot necessarily deliver tidy, universalised systems for urban water provision. In fact, in the context of my hypothesis, I see the split between needs and policy driven provision as analogous to the concepts of livelihoods and governance that appear in my research question. My additional comments on the DPU wheel, which nuance the original categories, arise because, mediating between policy and needs, or rather, governance and livelihoods, are socio-technical systems. The configuration of these socio-technical systems mean that modes of urban provision straddle the DPU categories and tend to coexist with each other.

I now look at the forms that this mediation takes, arguing for four dominant splintering mechanisms: privilege, bypass, resistance and networking. I then bring these mechanisms into a final discussion of vulnerability and how these ideas fit into my model of socio-technical space developed in Chapter 2.

9.2.1 Privilege: Wanchaq, San Bias and rational prejudice

Returning to the case studies and placing them in the broader context of Cusco, it is possible to distil out the mechanism of privilege. Residents in San Blas expressed the view that certain zones were regarded by the provincial water company as more important than others. This issue was probed during an interview with the CEO of SEDACusco. He began by explaining that demand varied according to social behaviour and activity and then explained that tourist zones had to have priority. This also applied to the residential area in the Wanchaq District because, according to the CEO, they paid the most in fees.

> In social terms, there is another complexity because demands are different in each sector. [Our studies show that in the north-eastern zone, the amount provided based on the estimated demand comes out at 100 or 110 litres per person per day. In other sectors we are talking about 250 to 300. Social behaviour is also a variable. In the zone where all the monuments are for example, it's basically an area dedicated to tourism so that it mustn't experience a water shortage. The residential zone to the south of it [Wanchaq] cannot have water shortages either because they are one of the main fee payers [contribuyentes].
>
> 34mins (SEDACusco Interview 1 2006)

This should be seen in the context of SEDACusco's ownership model. Shares in the company are divided up between the municipal mayors and this then affects the mayoral voting power and decision-making weight on the board of directors. Although this distribution of shares is enshrined in law and is ostensibly based on the number of connections per district, the reality is more opaque and the shares per connection, estimated in the final column of Table 30, show a wide variation in the number of shares allocated per connection. Wanchaq, the zone prioritised because users were reliable contributors, also has the highest ratio of shares to connections shown in Table 30.

Table 33 SEDACusco share distribution

District	Connections	Shares[155]	Shares per Connection
Cusco (San Blas)	19,700	1,250	0.06
Santiago (Manco Capac)	4,500	966	0.21
Wanchaq	1,500	710	0.47
San Sebastian	2,300	404	0.18
San Jeronimo	1,700	188	0.11
Urubamba	1,733	143	0.08
Paucartambo	384	47	0.12
Huarocondo	517	26	0.05

Note: Connections taken from Provincial Plan (Municipalidad Provincial del Cusco 2006), number of shares from SEDACusco's annual report (SedaCusco 2007a), Shares per connection are estimated by the author.

This allocation of shares not only reinforces the perception that zones were prioritised by SEDACusco but makes a practical difference at board level. By apportioning shares on the basis of existing network connections, decision-making power is biased towards the zones that are already well-connected. The second order effect is that investment in these well-connected areas is also prioritised because users are contributing to the company and their municipality.

Confirming this, the CEO of SEDACusco nicely sums up his ambivalence to those not willing to make such contributions. Using a rather insidious parallel with the cost of beer, this engineer explains what drives his organisation to prioritise certain areas:

> But in all the higher parts of the city, we have other problems: in some cases the population up there wants to belong to the water company and we don't want them to be incorporated. When they belong to the company and we invest in them, there are complications. First is that sometimes the perception is that what they have to pay [SEDACusco] is expensive. In reality the water is pretty cheap, say 10 soles (£1.70), really good value. 8 or 10 soles (£1.40-1.70) and in exceptional cases 20 or 21 soles (£3.40-£3.60). But in general 8, 10, 14 soles (£1.40, £1.70, £2.40). Very easy for anyone to afford, right? I have always explained to people: they go on a Sunday and drink a beer and there you've paid what you pay for a month of water! In reality, it's not expensive. But when we have problems supplying the water, for example, they come and protest and this reflects badly on the company. They pay the least yet giving them water is more difficult because they are in more complicated zones with need much higher investment and often they complain more.
>
> 34mins (SEDACusco Interview 1 2006)

The controversy over the allocation of shares has not gone unnoticed by other districts. The Mayor of Santiago, whose jurisdiction includes Manco Capac, was a firm advocate for Manco Capac's integration into SEDACusco. A SEDACusco takeover would of course "*increase the assets*" of the Municipality of Santiago, giving the mayor "*more weight on the board*". The mayor felt that

[155] Each share is currently worth S./25,152.76 according to Law 28870 (SedaCusco 2007a)

this advantage would balance out the backlog of unpaid council taxes and charges owed to the municipality by the inhabitants of the Right Bank (Municipality of Santiago 2007).

Meanwhile, in San Blas, commercial neighbours like hostels with links to international tourists have helped to attract SEDACusco's upgrade projects to the area, although these projects are still not able to deliver a 24 hour supply, mainly because the system's capacity has not kept up with rising demand. Household connections to sanitation – more invisible to visitors – have been upgraded by the NGO, the Centro Guaman Poma de Ayala.

SEDACusco's perception of risks, then, continues to be influenced by its institutional view of livelihoods in different settlements. Although SEDACusco's CEO was dismissive of the limits of household spending power, reasoning that his water was cheaper than beer, this missed the primary feature of needs-driven provision: affordability is not only a function of cost. In Cusco, the affordability of water was a function of cost relative to income *and* of billing periods relative to seasonal fluctuations in income. Integration for the inhabitants of the Manco Capac and the Right Bank meant water meters, billing and sanctions for late payment. These were worrisome risks for households that were just about able to buffer water affordability by deferring payment and using more expensive alternatives only when absolutely necessary. This insecurity meant that the reluctance to incorporate community systems came from potential users as well as providers. Consequently, what the CEO was most nervous about was not whether SEDACusco had the capacity to act or was the most appropriate provider to precarious livelihoods but rather the problems of cost recovery in the context of popular organisation and protest. This link between perceived risks and local governance must in part be fed by the context of popular organisation in Peru with its history, on one hand, of urban movements for social justice, and on the other, their manipulation by the centre to undermine Peru's regions.

More particularly, much to the chagrin of SEDACusco, which is otherwise so focused on cost recovery, in the north-eastern sector of Cusco water customers are still paying the social tariff that they negotiated when their water infrastructure was adopted by SEDACusco.

In summary, then, the spread of SEDACusco's investment and infrastructure across the city is not always homogenous or harmonious. In part,

this is driven by the EPS ownership model determined by Peru's national water legislation. The EPS framework also opens the way for global financial and technical links which help to strengthen capacity and investment. The frameworks for international capital prioritise returns, cost recovery and paying the true cost of water which means as little cross-subsidy as possible. Investment is prioritised in zones where cost recovery is anticipated and in municipalities which have sway at board level. It is also geared up to serve sectors considered strategically important for Cusco's economy, namely tourism. The effect of this is that investment is consolidated in zones where livelihoods are already perceived to be strong.

This first aspect of splintering – based on the division of the provincial water company's shares – results from a highly formalised and politicised allocation of power at board level. This entrenches existing differences in the access to influence in each municipality. Interestingly, what it has created internally within the municipalities is an incentive to integrate disconnected communities as a way to consolidate municipal power and representation at board level.

9.2.2 Bypassing the risky: Manco Capac

Despite its municipal ownership framework, SEDACusco has always and continues to operate in an environment where its systems weave around and between what the company's engineers refer to as "*parallel administrations*". SEDACusco describes these parallel arrangements in their feasibility study of the Right Bank:

> Parallel systems for managing drinking water bring with them problems with operating the network... The main causes are: poorly invested funds, a lack of technical training, inadequate billing, disorganised operation and maintenance of the system, a lack of logistics and the idiosyncrasies of the population. The lack of cadastral information is also a problem which affects the system.
>
> (SedaCusco 2007b)

One such parallel administration that still coexists alongside the formal water company is the ASAPASC organisation in Manco Capac. As we have seen, this system that was built by the population between 1985 and 1990. Its operation and maintenance are now the responsibility of the ASAPASC committee but as we saw in the previous chapter, the system's performance has deteriorated: yields from the water sources have declined, the population

has increased and technical and financial capacity to maintain the system has fallen away.

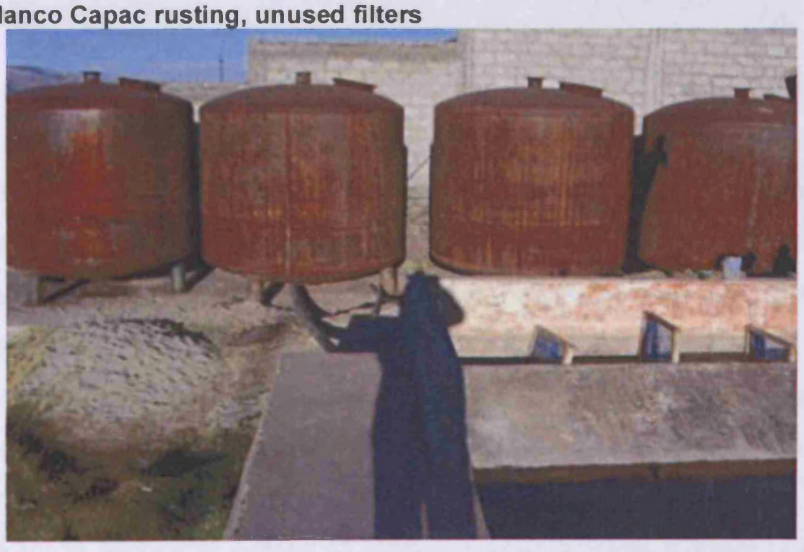
One local official blamed these problems on the water committee's dysfunctional management:

> ...the problem is ... the management. The economic resources or income that the board members have comes from charging for the water service. They don't have another source of income .... Basically, there are economic interests, just as much on the part of the population as the directors. Because ASAPASC is quite closed in this respect. They manage their accounts and so on. It's their own management, they're not very inclined to discuss things, they are not inclined to share information. Often they don't provide monthly reports to the population. It's quite difficult to get involved with them. Neither the Ministry of Health nor the Municipality of Santiago has got involved. They are very closed off.
>
> Anonymous NGO Official

Indeed, on my first visit to the filtration plant, I asked about four free standing containers which looked as if they had been intended as pressure filters. They were rusted and not connected to anything. Their history was explained by the administrator:

> One was bought by the municipality, one by World Vision and two by the population but the money to complete the project was mismanaged and went into the pockets of the local leaders. These representatives change every two years and once the fraud has been discovered it's too late.
>
> (ASAPASC Interview 2 2006)

Figure 89 Manco Capac rusting, unused filters



The consequences of these accounts for community engagement were extremely counter-productive. Although, in theory communication between the organisation and users was through assemblies and *faenas*, meetings held in the Manco Capac community centre, or *salon communal* were poorly attended

(ASAPASC Interview 2 2006). ASAPASC's president said that the executive board had lost credibility and blamed a general lack of confidence in the authorities (ASAPASC Meeting 2006). World Vision confirmed this:

> [meetings] do not happen very often because the management committee or the directors elect themselves every two years... and sometimes only every three years.
>
> 23mins (World Vision Interview 2006)

My repeated attempts to organize a community meeting and to piggy-back on other local assemblies as part of this research project also came to nothing and, in the end, the results of water testing were presented over the course of a day at a main junction in Manco Capac.

Figure 90 Manco Capac community session

These internal process in Manco Capac can also be framed as a continuation of splintering. The macro urban drivers of bypass and privilege are mirrored in the personal livelihood priorities of the water committee. Local resistance finds echoes in collective action confined to very small areas. In Manco Capac, institutional linkages which were so useful in Angostura, are characterised by mutual suspicion in relationships between householders, the municipality, the provincial provider and civil society actors.

The large technical extent of Manco Capac's water system is contrasted with the small social reach of residual collective action at the level of housing blocks: mismatched social and technical scales. This was an issue for the CGPdA whose personnel saw distinct limits in the capacity of community organisations to operate their own infrastructure across the spectrum of the

technical (operations and maintenance) and social (user engagement and funding).

In spite of the apparent disconnect between the community and their water committee, it was with ASAPASC that SEDACusco, obliged by Peruvian legislation, recently began negotiations to take over the water infrastructure on the Right Bank. As part of this deal, SEDACusco is proposing new meters in order:

> ...to implement an effective control of water consumption among the inhabitants through the installation of macro- and micro-meters.
>
> (SedaCusco 2007b)

It is also determined to impose a normal tariff structure. This is perhaps unsurprising given what the company still sees as a bad experience with social tariffs in the north-eastern zone, which will be covered in the following section. When the company's engineers were questioned about the social tariff idea their view was that the infrastructure for which the population would be compensated through the tariff was so decrepit that its value would be written off immediately (SEDACusco Interview 2 2007). When it was put to the team that the population had a very personal stake in their infrastructure[156], their response was to make the analogy with owning a car:

> If you run a car for 20 years and never do any maintenance on it, it is worth nothing. The same holds for ASAPASC's water system.
>
> (SEDACusco Interview 2 2007)

SEDACusco's proposal rests uneasily with the population on the Right Bank. Firstly, negotiations with SEDACusco are taking place through ASAPASC, the water committee. As we have seen, the relationship between the committee and the community is strained, although the former president of ASAPASC and a longstanding member of the board was vehement that "of course the population will be involved!" (Interview with former president of ASAPASC (HH34)). This optimism should be seen in the context of community engagement summed up by the local World Vision representative:

[156] On whether SEDACusco had any sort of mechanism for engaging in negotiations directly with the population – not just ASAPASC – the answer was no, followed by a rather baleful "you?".

> The population is divided! Because the average tariff that ... the ASPASC users pay is 4 soles (69p) per month, while the tariff that SEDACusco sets, which is a "social tariff", fluctuates between 10 and 12 soles (£1.70-£2) per month... There is a part of the population that wants to switch over [to SEDACusco] and another part of the population, generally the oldest inhabitants, that does not want to switch over. The discourse that they adopt is that they... have worked in the faenas to bring water from such a distance to the right bank that ... they can't bring themselves to give it over so easily to SEDACusco. And the SEDACusco tariff is higher, right? And when the social tariff period has passed, SEDACusco will start to charge the real costs. The population that wants to switch over is the population that sees that the water service is inadequate. So, for health reasons ... they want to switch. But when the moment comes for them to get together in a general assembly and it comes to a vote those who don't want to switch always win.
>
> 7mins (World Vision Interview June 2005)

Secondly, in addition to the health risks perceived by parts of the population as sufficient reason to opt for SEDACusco, other interviewees observed local economic interests as a factor. The ASAPASC maintenance team, for example, suggested that since the arrival of the main bus station, located at the foot of the Right Bank, several landlords had opened small hotels and they now wanted SEDACusco to adopt the infrastructure because their businesses depended on a reliable water supply. Meanwhile other landlords were renting out 4 or 5 rooms and charging each tenant for water services. They did not want SEDACusco to become the service provider because the higher cost of a metered service would eat in to their rental income (ASAPASC Interview 2 2006). These interviewees distinguished between landlords with "customers" expecting a certain level of service in a hostelry and landlords with "tenants" who would just have to lump it.

On this theme, the representative from the Centro Guaman Poma de Ayala commented on the circumstances in the Right Bank:

> There are people there that are manipulated, so in an assembly they say "we are not going to get involved in the [SEDA] project"... [Their self-managed water company] has serious problems right now because... there are local leaders that have exploited the system...they don't want SEDA to come in. There are sectors of the population that want the company to intervene but all the networks, the whole system is damaged. SEDACusco says to me: "how much is this going to cost me? If I intervene, the population is going to have to bear the cost! As soon as I go in, they'll ask me for clean water!"... But still there are sectors of the population that are against [SEDA]... it isn't only a question of lining their own pockets, because they charge [for the service over there], but there is also a political motive... to put themselves up for public office or to get into the municipality, to be visible, right?
>
> 30mins (Centro Guaman Poma de Ayala Interview 2 2006)

For the Centro Guaman Poma de Ayala, resolution of these conflicts and management problems is a matter of "sustainable institutions". One aspect of this is the need to integrate projects across groups of settlements. Once water and sanitation is installed, a new, one-off management organisation at the level of a single barrio is hard to sustain because:

> ...in a barrio that already has water and sewerage, a new organization dies. Everyone has their own thing going on.
>
> 33 mins(Centro Guaman Poma de Ayala Interview 2 2006)

The CGPdA also acknowledged that community based water organisations in the city can coexist with larger providers but that water provision at a local level is not sustainable since:

> It needs specialization. It needs a management, a much more professional structure, more scientific. But [our community work] demonstrates...again and again that the social organization, the neighbourhood meetings, no matter how organized they are, have their limits. And one of these limits is in the management of this [water] resource. So [our work] has demonstrated that they can't run [things]. It's impossible. Each time we consider future projects, our institutional policy is that the project must be managed by an organization that knows how to do so. Because if not... the project is bound to fail. It will not be sustainable and eventually it will collapse...our position has always been that we provide support from the point at which you take the decision to transfer [the system] to a new management, to SEDACusco...
>
> 25 minutes (Centro Guaman Poma de Ayala Interview 2 2006)

Extending services into communities that are regarded by local government or the water company as financially risky or politically recalcitrant thus remains problematic. These perceived risks are linked back to livelihoods and governance.

Insecure incomes across this swathe of Santiago District also mean that Manco Capac is one of several barrios considered to be in arrears with local taxation. This contributes to the municipality's fiscal inability and general reluctance to include the area in waste collection services and this, in turn, feeds the population's antipathy towards the municipality.

Manco Capac faces an abysmal water service but it is also vulnerable to underinvestment in other infrastructure like roads and pavements and environmental hazards in the form of seasonal rainfall and flooding of gullies. There is frustration with waste collection services and the fact that waste is thrown into the neighbourhood ravines but, with little residual connection to agriculture in the southern valley and most of the settlement perched well above

the flood plain, there is not a great deal of preoccupation with where waste water ends up.

In addition, in Manco Capac, priorities have shifted to livelihood activities in other locations in the city. Some community organisations are still active but are concentrating their efforts in small areas and slowly sealing roads or building pavements around single blocks of housing but the water system, which is geographically spread, has been allowed to fester.

What is clear from the different stories of past and imminent integration of water infrastructure is that there is no set framework for the adoption of community supplies. Each time this happens, the water company, the municipalities and the community have to renegotiate the value of the community infrastructure and haggle over suitable compensation. The Cusqueña tradition of popular organisation to develop settlements and infrastructure may originally have succeeded in providing basic services but, when the immediate need has subsided, the initial leadership has not necessarily translated into sustainable management: Manco Capac's water system is a committee-run system rather than a community-run system.

In addition, though the DPU's work cited successful examples of relationships between provincial providers and communities like Water Forums [157], what we find in Cusco, is a rather rueful and antagonistic relationship between the company and the communities whose supplies it has integrated. User participation, then, as a "new opportunity for cost recovery" (Mitlin 2001):152 has not been welcomed as Diana Mitlin predicted. Instead, it is seen as an investment risk. Navigating an institutional response to the coexisting policy and needs driven provision is complex. Just like the private concessionaires from Ana Hardoy's Buenos Aires study, the commercialised SEDACusco does not have the inclination at high level and consequently the capacity through the organisation's different departments to work with communities in a participatory manner.

Although for many households, livelihoods would be substantially altered by a different provision arrangement, engagement in decision-making has given way to apathetic mistrust and the perception that while a few householders might be benefiting from the status quo, a new system with meters, fees and anonymity might disadvantage the worst off. The water committee, however, is

[157] Built on the tenets of participative democracy laid down in the 1999 Constitution...

still the chief negotiator with SEDACusco, further reducing the population's access to influence and reinforcing the socio-technical isolation that is reducing the complexity and diversity of livelihoods and exposing households to vulnerability.

This splintering also applies to the isolation of the system and the committee from any international or municipal support. Apart from donations from an international NGO right at the start of the system's history, ASAPASC has not manage to cultivate any financial or technical links into bigger socio-technical systems that might be able to support it.

9.2.3 Resistance: recalcitrant parallel administrations, social tariffs and ambiguous risk sharing in the north-eastern zone

Other examples from Cusco suggest that bypass can be overcome. In fact, there is a history of attempts to integrate autonomous community systems into the SEDACusco system. One of the best documented examples is the *Zona Noreste*, the north eastern swathe of the city just along the mountainside from San Blas and characterised by a steep, clayey slope whose vegetation has all but disappeared over the last 40 years [158]. Eleven of the zone's neighbourhoods (APVs) were served, like San Blas, by SEDACusco's Santa Ana reservoir but eleven others had their own, self-managed spring sources, distribution networks and reservoirs. These had been financed and installed by the population, working in teams at weekends. According to research in the early 1990s, the systems had hardly any technical input and as a result reservoirs and pipes were wrongly sized, materials were unsuitable and the yield rates did not meet demand, limiting hours of service. A further fourteen APVs, the most recently formed, had no service at all and were unable to finance anything because they were caught up in the financial crisis of the late 1980s (Frias et al. 1992).

SEDACusco viewed these parallel installations as "private projects" and kept them very much at arm's length until 1992 when the provincial company was finally obliged by its new EPS constitution to bring urban systems under

[158] It is riddled with unstable gulleys and prone to landslips and erosion. Part of the zone covers archaeological reserves and because of a belief that evictions are more likely from heritage sites, the zone's precarious inhabitants have ripped out the ancient terraces which traditionally stabilized the slopes. According to a 1992 study, the population of thirty-six APVs identified drinking water and drainage as their top development priorities.

one umbrella (Frias et al. 1992):14. However, this move to draw in autonomous systems met resistance in four barrios that had become isolated during the zone's transition to SEDACusco (Centro Guaman Poma de Ayala Interview 2 2006). According to a head of department at the CGPdA, the community leaders in these barrios insisted that they would manage their own systems and refused to hand over their infrastructure. This was in spite of a long term agreement with the water company that they would be charged "social tariffs". The principle of this social tariff is explained by one of its proponents at CGPdA:

> The social tariff is a payment, let's say that it recognizes the work and the effort contributed by the population to achieve this project. This is a low, flat tariff, so they signed an agreement where commitments were given by the water company on one hand and by the population on the other. And of course several years have passed and the company has not invested much in the zone. The thing that they have respected is the social tariff. Each new company director that comes in says "we must cancel this contract". But the unity and strength of the water committee has prevented this contract being forgotten.
>
> (Centro Guaman Poma de Ayala Interview 2 2006)

Instead, these barrios continued to run their own system charging a nominal fee, which was either never collected or was embezzled, and only occasionally rallying the population to clean the reservoir. Their system deteriorated and it was only when the regional hospital began to notice higher incidences of gastrointestinal and skin infections in these areas that the community began an internal battle to allow SEDACusco to become their provider.

In some respects, this transition is still awkward fifteen years later as it faces population growth and is plagued by an ambiguous arrangement over the responsibility for planning and maintenance and a lack of investment – this time on SEDACusco's account :

> ...since [the north-eastern zone] has been transferred, [it] has grown a lot, mainly because it has water: only those that have water grow. But there's no expansion plan. So, [SEDACusco] should have said "look, 5 or 10 years from now we will have to increase the [filtering] gallery to improve collection."
>
> The barrios working together with [the Centro Guaman Poma], supported by us, have carried out annual faenas for five or six years now to improve the artificial recharge of the [collection] ditches. This ought to be done by the water company but they have never done it. The most they have done is to provide a bus to take the users up so that they can carry out their faena. The neighbourhood does this each year. It's the responsibility of the company but the neighbourhood knows, they realize, that they have to do it otherwise the flow rate will fall. So it's [an aspect of] a management that falls to the zone in the face of the company's [inaction]

26 minutes (Centro Guaman Poma de Ayala Interview 2 2006)

This rather unsatisfactory relationship is still seen by SEDACusco as a thorn in its side because, as the CEO confirmed, it has committed to charging social tariffs and consequently cannot bring itself to invest in the system it has adopted:

> This agreement [over a social tariff] cannot be left in place indefinitely. And it was a mistake not to have established fixed timescales for it. So, there is an agreement with the users, who at one time worked [on the system], because they demanded a preferential, social tariff. However, if there were originally a hundred people in the zone, there are now 200 and we have to charge those 200 the social tariff: this is unmanageable. While it is very clear to us that [this arrangement] is not fair it is very difficult to make the [population] understand... it is very complicated for us, in fact, to make investments... we have made several improvements, most importantly in the hydraulic performance of all the networks but we cannot do anything more because we simply cannot justify the operational costs when seen against the income [from this zone]. It doesn't stack up. Not even the current operating costs for the zone. It's very complicated and it has brought with it many social conflicts: water is the rallying cry [bandera] for all those that want to go to this area.
>
> 47mins (SEDACusco Interview 1 2006)

When it came to parallel administrations that continue to operate in the city, the views of SEDACusco's CEO were unsurprisingly echoed by the company's operations team. The then head of operations explained that in peripheral areas of the city, in particular the Right Bank home to Manco Capac, low income families do not want meters. Unfortunately, these peripheral areas coincide with those that presented the worst technical problems, especially in terms of topography. They therefore required more investment and this would preclude the application of a social tariff (SEDACusco Interview 3 2006).

One view was that improvements to the network ought to be cross-subsidized by commercial users but the engineer offering this option conceded that this could not be done to the degree needed to extend into marginal low income zones because tariff policies were set out in national legislation and tariff levels had to be approved by the national water regulator, SUNASS (SEDACusco Interview 3 2006).

This was a source of frustration for SEDACusco's CEO and limited the company's ability to invest. The CEO framed this as a problem of low tariffs rather than a difficulty associated with lack of cross-subsidy between commercial and residential users:

> Tariffs are proposed by [SEDACusco] and approved by SUNASS. We last proposed rates in 2000. But on this issue we have a lot of conflicts with SUNASS over the application of the tariff adjustment which has been frozen since 2000. Only in the last few months have we been able to make an adjustment for inflation. In 2000 we allowed for 3% inflation but it has actually been at times a little over 10%. So the company is losing out, in terms of the cost of water, we have lost this real value, 7%. This means we cannot make good investments, we cannot maintain our infrastructure to the required standard because we don't have sufficient resources. Often the problem with SUNASS is simply procedural: it has the option to make the adjustment...and it just doesn't deliver. It's ridiculous.
>
> 36mins (SEDACusco Interview 1 2006)

Overall, though, it is clear that SEDACusco's investment response at municipal and community level is highly sensitive to perceived cost recovery and political headaches and the ideal of integrated water provision gradually absorbing community systems and improving services can still be uncomfortable.

An additional reason for this awkwardness goes directly back to the ownership model of SEDACusco and the controversial and very recent history of its share allocation.

San Jeronimo[159], the district sandwiched between the city centre and Angostura's district of Saylla, withdrew as a shareholder in 2003 and took back most of their infrastructure from SEDACusco's management. The politics of this separatism was explained by the local NGO, Centro Guaman Poma de Ayala and it tells a story of the geographic nature of the water company's assets. Wanchaq as we have seen is a prosperous, central residential district with a large shareholding but no water company assets within its jurisdiction. San Jeronimo is a more deprived, outlying district with many of its own assets which predate the incorporation of San Jeronimo into the water company. San Jeronimo also hosts the city's single, odorous waste water treatment plant:

> ... San Jeronimo, for example, has withdrawn from the company so that it can manage the system itself. It's a problem... the mayor [of San Jeronimo], at the beginning of his administration... resigned from SEDACusco in part because the distribution of shares was [unfair]. Wanchaq, for example, doesn't have any water sources [within its jurisdiction] but wants to have the same weight as a shareholder. So, San Jeronimo said "wait a minute, I have reservoirs, networks, water sources and I have invested in these [assets]. Compare this to Wanchaq which has never had [these things] and has had everything provided for it! How can we have the same shareholding?" This [distribution of assets] was one of the pivotal issues [for San Jeronimo]. It is still not resolved. The company

[159] In San Sebastian the SEDACusco still runs 80% of the system and the municipality runs 20% while in San Jeronimo the municipality runs 70% of the system and SEDACusco runs only 30% (SEDACusco Interview 5 2006)

> wanted [the distribution of assets] to stay the same but the [San Jeronimo] municipality did not agree. So how, for example, does [San Jeronimo] make its views felt? By charging the treatment plant council tax!
>
> 45mins (Centro Guaman Poma de Ayala Interview 2 2006)

For the Centro Guaman Poma de Ayala, this movement to break away from the provincial EPS, SEDACusco is particularly concerning because it can provoke further disconnection of systems. CGPdA's experiences working to improve the understanding and application of the constitutional concept of a *Junta Administradora de Servicios de Saneamiento*, or JASS, which dates back to 1994 in terms of legislation if not implementation, has made them wary that municipal level splintering can lead to a situation where services further fragment when municipalities are unable to maintain their district services (Centro Guaman Poma de Ayala 2006a):

> We have always maintained that the JASS should only exist in [more isolated] communities because [there] the municipal institution does not have the resources to reach them. But this doesn't apply to population centres at the foot of the valley. What has to be coordinated is the local government. But some authorities, some local governments, to detach themselves from these responsibilities, [like] the initial investment, they say "you want a JASS? Set one up yourselves then!" in order to wash their hands of it. They won't take responsibility. But they don't realize that further down the line it's worse. On the other hand, there are citizens of the barrios that say: "Great! The municipality has handed over the water. Once they give it to us we'll set up our JASS and we'll run it ourselves." And the municipality says "Great! Bye!" [The community] says: "when we run things, we'll pay 50 cents!" or "we'll pay once a year!" So there is a financial interest. They strike deals, look for sources of finance, don't tell anyone about it. But the problem is the water quality.
>
> 46 mins (Centro Guaman Poma de Ayala Interview 2 2006)

With San Jeronimo breaking away from SEDACusco, further splintering within the municipality itself has been prevented by supporting the municipality to run its own system and by efforts to keep other districts tied back to the city, if not physically, then certainly institutionally, through socio-technical systems of water and governance.

9.2.4 Networking: linking autonomous systems to hubs

The other effect of San Jeronimo's new independence has been to isolate the next district down the valley from SEDACusco's support. This district is Saylla, home to Angostura.

As we have already seen, livelihoods in Angostura are mixed with some inhabitants in stable, formal sector employment and others dependent on highly seasonal agriculture. Local agricultural livelihoods are often combined with small home-based enterprises and even diversified livelihoods tend to operate very close to the settlement. These livelihoods do not necessarily allow community investment but they do permit high levels of participation and the contribution of labour for construction of infrastructure.

Crucially, recognising that the incremental improvement of community infrastructure involves social and technological connection to larger institutions, CGPdA has begun helping individual settlements like Angostura to set up the JASS water committees.

The interlinked issues with Angostura's JASS, however, are the usual suspects: lack of capacity, lack of funds and poor water quality. Firstly, there is little local capacity in terms of time, money and skills to monitor and document performance. Secondly, there is no regulatory agency to pick up, punish or address poor performance. Thirdly, the regional health authority – which has no enforcement powers in any case – is already stretched with its responsibility to monitor the large, formally regulated and occasionally politically controversial EPS. In spite of this and thanks to the support of CGPdA, the system is performing well against all the WHO indicators except quality, which was variable.

The Angostura JASS owes its successful performance in part to CGPdA's broader environmental vision: the engagement of communities and municipalities in the regional water management initiative for integrated water resource management, known by its Spanish acronym, GIRH. One of CGPdA's current efforts, for example, is to bring together all the *fontaneros* [maintenance staff] from the southern valley at workshops on running small water systems[160] and to encourage those leading the JASS committees to share their experiences of making each incremental technical improvements.

The importance of these initiatives was explained by the representative from CGPdA with reference to Cusco's north-eastern zone. This NGO, having observed the difficulties of opting in or out of a municipal system at the peri-urban interface, sees institutional support to municipalities as the key to

[160] Including one female fontanera of whom CGPdA are very proud! The workshop included sessions on the design of gravity-fed systems, chlorination, monitoring and group planning exercises (Centro Guaman Poma de Ayala 2006b)

successful infrastructure provision and justifies this with a description of the barriers to bringing dispersed or peripheral infrastructure under municipal supervision:

> More than the rest of the city, the north-eastern zone and the southern valley are linked to the urban as well as the rural...so at some point we said to them: "should this community become part of the municipality or not?"... There are lots of political [pre]conditions involved...technical [pre]conditions. For example, Saylla [Angostura's host district] hardly has anything! It doesn't have a single engineer. They have their fontanero [maintenance man], that they've trained. But the fontanero on his own cannot deal with the water issue and clean the streets and deliver the documentation to the mayor... This is municipal level policy. So there are situations that are a little complicated. It's not straightforward.
>
> 26 minutes (Centro Guaman Poma de Ayala Interview 2 2006)

In the north-eastern zone, municipal control of the inhabitants' water meant being subsumed into SEDACusco's nearby system. However, for settlements at the foot of the valley, like Angostura, CGPdA has had to come up with an alternative vision for municipalities like Saylla that are unlikely to ever become shareholders in SEDACusco.

CGPdA has a long term plan that these dispersed JASS committees will eventually be linked together under an administrative umbrella that is able to offer centralised technical and financial support. Their engineers see this as a 10 to 15 year development project and accept that, as it unfolds, some settlements will have waste water treatment while others do not; some settlements will have chlorination while others do not; and some settlements will have meters while others do not. A sustainable system, on this view, is one in which human capacity keeps pace with technical sophistication, learning is shared and support networks stretch much further than the water network itself.

All these efforts downriver in Saylla, however, are dwarfed when they are tracked back to the inadequacy of SEDACusco's sewer network and the direct discharge from communities both within and outside the SEDACusco system. In fact, the socio-technical mechanisms which mediate vulnerability are perhaps even more pronounced but much less visible in Cusco's waste water infrastructure.

Although SEDACusco operates one waste water treatment plant for the city and charges all its users 42% of their water consumption to cover the cost of this treatment, according to an internal report (SedaCusco 2005), waste water from San Blas is actually discharged into the underground River Saphy –

a tributary of the Huatanay – and never arrives at the treatment plant. Similarly, Manco Capac and all its neighbours on the Right Bank rely on a network of 6-8" combined sewers[161] for foul water and surface water. These discharge directly into the River Huatanay with no treatment at all.

The CEO of SEDACusco was keen to point out that although the company faced criticism for the state of the River Huatanay, it was not set up to deal with the problem of collecting waste water from informal settlements:

> ...another problem has arisen...for which the responsibility is not absolutely with the water company. We have pollution right now that is being generated in the River Huatanay...the company has already encountered [human] settlements on both sides of our river, left and right and they don't have sewerage services. Or they already have a drainage service set up or built the by the people themselves and discharging straight into the river. This is an externality that comes back to the company and that, let's say, in economic terms, we do not have the capacity to cope with. So, the relationship between the municipality, the community and the company ought to be a bit more formal... to avoid the development of these settlements in places that don't have basic services. I know that everybody... the whole community, the newspapers, the specialist agencies say "no! the pollution is SEDACusco's fault!" but how can we respond? Our view is that the reality is different: the company does not take on communities that go in and install themselves. On the Right Bank, those already living there come to the company and say "you have to connect me" and it doesn't work like that. We work in sections according to our master plan of work... and if we are not scheduled to lay parts of the network over there, then realistically they shouldn't be accepted [into the system]. And in the great majority of cases, I understand, they are what we call invasions, they're informal. Only with time do they become formalized.
>
> 24min (SEDACusco Interview 1 2006)

Apart from all the waste water that is not contained by SEDACusco, the flow rate of waste water from the areas that are connected to SEDACusco sewerage is about 600l/s and – with Cusco's combined sewers – during heavy rain this flow can be up to 1600l/s but the San Jeronimo treatment plant has a maximum capacity of 395l/s, so anything over and above this in the rainy season is diverted into the river without treatment (SEDACusco Interview 5 2006). Over the course of a year this works out at about 2 to 3 hours discharging directly to the river every day between December and April.

The monitoring of water discharged by large commercial and public sector users and the treatment plant is also completely dysfunctional. According to SEDACusco's site engineers, there is no enforcement of the legislation on

[161] In SEDACusco's analysis using the rational method, the system capacity was shown to be wholly inadequate (SedaCusco 2007b)

discharge from the plant[162] because the relevant law, passed in 2005, has yet to be implemented by the "disorganized" regional health body, DIGESA. There was a feeling that for commercial users, there was a better chance of enforcing limits because of the water company's power to sanction:

> Each company must treat its own waste. The limit is 250mg/l BOD and if this is exceeded, SEDA can block off their drains
>
> (SEDACusco Interview 5 2006)

Although on alternatives such as the decentralization of residential waste water treatment, staff at San Jeronimo were dismissive:

> We can't decentralize because of lack of space and high population density!
>
> (SEDACusco Interview 5 2006)

In contrast, right after the San Jeronimo plant, rounding the next meander we find Angostura and the concerted efforts of CGPdA and the municipality in Saylla to support decentralized waste water treatment plants for every settlement in the district. These primary treatment plants[163] built mainly with contributions from the municipality and an external NGO are now between two and six years old and are operated by the community water committees (Centro Guaman Poma de Ayala Interview 3 2006).

Figure 91 Aerial image of San Jeronimo waste water treatment plant

[162] Incoming DBO is 250mg/l, outgoing is 70mg/l. Incoming coliforms 10E8 and outgoing 10E5or6. The relevant regulation says it should be 10e3 for irrigation water.

[163] Each decentralized plant is designed for complete manual operation with no moving parts at a cost of S./150,000. The network cost is about S./90 per linear metre (Centro Guaman Poma de Ayala Interview 4 2006). The costs break down as 30,000soles from the Municipality of Saylla, 1,500 soles from users, nearly 60,000 soles from the organisation International Solidarity and 1,500 soles from Centro Guaman Poma de Ayala (Gonzales et al. 2003)

As we saw in Chapter 6, the contamination of the River Huatanay has an impact on livelihoods, health, sustainable agriculture and the food chain beyond the provincial boundaries of Cusco yet, of the three case studies, only Angostura has any waste water treatment.

In response to some of these problems, the inter-district development initiative launched by CGPdA aims to assemble regional actors, strengthen municipal authorities and integrate the management of water resources across jurisdictions. So far this has allowed the development and long-term support of small JASS organizations and investment in decentralised waste water infrastructure. A series of forums has also helped to persuade the regional health body to extend their drinking water monitoring into the municipalities of the southern valley:

> A year ago, DIGESA [the regional health body] started getting involved, following the [existing] legal framework. Before that there was no monitoring. The Ministry of Health was supposed to do it but who knows what they did! Now it happens more regularly. For example in the southern districts, the Ministry of Health runs monthly quality checks for residual chlorine at least. Before it was the responsibility of the municipality and the Ministry of Health came in if people were ill. But now with this framework, there has to be monitoring. Our institutional policy is to strengthen the local government institutions so that they

> can manage [the systems]. So that there are stronger, professional municipalities with more developed human capital. Through the [inter-district development initiative] 'PIDES' the rates of diarrhoeal illnesses have fallen and the flow rates from water sources have been increased. We are also incorporating metering.
>
> (Centro Guaman Poma de Ayala Interview 2 2006)

The disconnection of Angostura from the possibility of SEDACusco's support and the need to engage the Municipality of Saylla in development across many districts has attracted the support of CGPdA in the design and funding of the water system. Angostura still sees the active involvement of users in maintenance and development of their infrastructure and in the water committee but the settlement's community-built assets are networked to CGPdA's capacity and the burgeoning capacity of the municipality.

The CGPdA has recognised that participation is not a spontaneous fact of poverty either in terms of users participating in their provider organisations, citizens participating in their municipalities or those affected by hazards having access to those causing them. With this in mind, its initiatives focus on municipal capacity both to foster participation and to participate in forums that cross jurisdictions and integrate the basin of the Huatanay.

With a poorly functioning waste water treatment plant and disconnected informal settlements and municipalities that have opted out, this splintered urban provision has environmental impacts that reach beyond the province. This splintering is amplified by the asymmetric experience of environmental hazards with Angostura and other settlements by the river closer to the city centre vulnerable to flooding.

At the same time, the river, which links agriculture and amenity value back to urban livelihoods offers a glimmer of hope for collective action around environmental issues. Strengthening the municipalities means that the CGPdA's intervention is designed to have a durable, incremental impact on human capacity and technical performance.

9.3 Answering the research question: placing messy modes into socio-technical space

For Marvin and Graham, 'bypass' is a process whereby the strengthening of infrastructure connections between the most valued people and places, (i.e. those judged to be lucrative and profitable to the infrastructure service providers), leads to a weakening of the connections between the least valued users and places (Marvin and Graham):288. What is important here is that connections are self-reinforcing: the more that strong places are networked with each other, the more these networks are able to straddle the neglected, regardless.

In the same vein, Bruno Latour's analysis conceived technological networks as "nets thrown over spaces" (Latour 1993):118 which simultaneously connect geographically distant people and places and exclude the locally disconnected. Latour uses this as a basis for explaining why ideals of universal service provision have little to say about contemporary infrastructure in Cusco or anywhere else. Building on Latour's ideas, Marvin and Graham's urban splinters are globally connected but locally isolated enclaves of privilege which coexist beside globally isolated or bypassed local infrastructures.

Splintering is useful for framing the processes of privilege and bypass which are prioritising infrastructure investment in zones where livelihoods are already strong and connected globally, like Wanchaq District and, to some extent, San Blas at the northern edge of the tourist centre, and bypassing the riskiest places and users.

SEDACusco's risk aversion has played out as a 15 year interval between when the company was legally obliged to integrate Manco Capac into the provincial supply and its 2007 feasibility study for this adoption project. In the north-eastern zone, this means that users still do their own collective work to maintain yields from their sources otherwise neglected by an ambivalent SEDACusco focused on cost recovery and unhappy with a longstanding tariff arrangement in this part of the city.

Resisting this splintering, Marvin and Graham see the difficulty of totally isolating privileged enclaves from urban or regional services such as power and water. In Cusco this resistance has been provoked by two factors. Firstly,

because Cusco's people have not been completely passive in the face of bypass and privilege with the example of San Jeronimo's disgruntled break away from the provincial system. At first the Centro Guaman Poma de Ayala had been nervous that San Jeronimo's socio-technical separatism would cause further splintering through a continued process of bypass down the southern valley. Instead, the settlements like Angostura, which spill out and down from San Jeronimo, are building networks between local livelihoods and global knowhow, facilitated by CGPdA and supported by inter-district cooperation. These were starting to produce reliable water services.

At the same time, however, to suggest that some things are going well for Angostura should not detract from the fact that this settlement is not only bypassed by many of the city's income generating activities but actually remains extremely vulnerable to environmental hazards that are exacerbated by activity up river. This active damage is a worse outcome than simple isolation from resources predicted by McAslan (McAslan 2002):141.

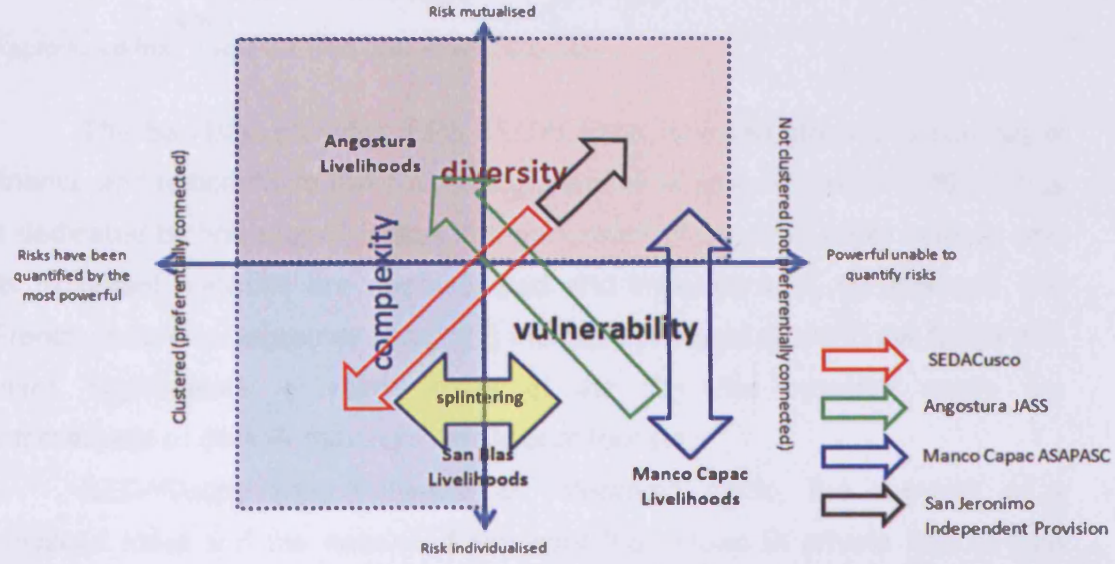
Secondly, the spaces between Cusco's water networks are not completely technologically vacant: they host interdependent livelihoods, committees and rivers. This tends to mean that not all spaces fall into the category of either privileged or bypassed: the networks themselves stretch, transition and interconnect across splinters. Looking back for a moment at the conclusions of Marvin and Laurie after their research in Cochabamba, Bolivia, we can see similarities between the interconnection of Cusco's splinters and what these authors' call the meshing of informal and formal water circuits. They present a picture of incorporation that rejects the monopoly of engineers and requires more complex social relationships between users and providers and smaller-scale technologies (Marvin & Laurie 1999):355.

Certainly, where the approach of SEDACusco scales up, monopolises and bypasses, there is room for new types of knowledge, or at least new holders of knowledge, for example, the municipalities, citizens and *fontaneros*. This does undoubtedly require more complex social relations with users, including participation, transparency, co-operation and, perhaps, patience since improvements are incremental. It is, though, in their final argument for smaller-scale technologies where the socio-technical configuration of infrastructure is particularly relevant. Small technology is not the complete response to the informal or bypassed. It is also necessary to scale up socially through links to

knowledge, which may be internationalised or held by engineers, but may more often be local and revolve around those who have either seen through successful plans or made alarming mistakes: Manco Capac, for example, is very close geographically to the successful, incremental experiences of *fontaneros* in the southern valley but these groups do not yet have mechanisms through which they can share practice.

Montgomery et al. also conclude that "links are needed to the powerful" (Montgomery et al. 2004):47. This is a question of access to influence and relates back to governance, coalitions of poor and non-poor and heterogeneity of urban livelihoods. Where links can draw in different livelihoods and vulnerabilities, time horizons and institutional and geographic scales, bypass is more likely to be constrained.

This is an argument for socio-technical systems as risk sharing groups where different modes of organisation push providers and consumers towards certain configurations: some of which allow risk to be mutualised and some which do not. This is mapped on the framework below. Different providers are shown according to the direction that their model of provision is pushing towards.



The configuration and interconnection of these socio-technical systems can also be understood through van Vliet et al.'s framework of co-production that feeds into their thesis of sustainable consumption. Slotting some of Cusco's coexisting modes of organisation into van Vliet et al.'s categories is an exercise that brings us almost immediately to their useful critique of scale, as shown in Table 31. These authors suggest that the technological scale of a system is not

necessarily matched by the scale of social organisation managing it (van Vliet et al. 2005):64.

Table 34 van Vliet et al.'s modes of organisation

Mode	Description	Application to the case studies
Autonomous	Co-providers, localized resources, local stand-alone, self-managed and responsive grids	Angostura with its water committee, community participation and spring-fed network
Piecemeal	Customers and suppliers, patchwork of grids, unregulated, non-standard, designed for peak loads with idle spare capacity	Manco Capac with its unregulated and unreliable patchwork of grids. Originally designed for peak loads but now struggling to meet them.
Integrated	Consumers and promoters of diversified demand, semi-integrated local and regional grids, designed for diverse loads to exploit spare capacity and smooth demand profiles	San Blas with its SEDACusco supply taking in surface, spring and ground water sources up and down the valley, buffering demand with distributed reservoir infrastructure and serving commercial and residential users.
Universal	Passive beneficiaries and public providers, uniform services, highly integrated national and regional super grids, demand not differentiated just met by extending networks	The Peruvian public ownership ideal which was in favour in the 60s, 70s and mid-eighties, and out of favour in the early 80s and early 90s, never achieving universal provision but strong enough to maintain a public ownership model for urban drinking water and sanitation.
Marketed	Purchasers and promoters of differentiated products and services, partially fragmented grids matched to diverse, monitored and manipulated needs	In patches, SEDACusco, markets a macro and micro-metered service and operates several tariff models which differentiate its services and feed back into investment priorities.

Reproduced from Table 3.1 (van Vliet et al. 2005):33

The San Blas provider, EPS SEDACusco, is linked globally to sources of finance and nationally to the shared experiences of other Peruvian EPSs. It has a dedicated technical staff, it taps into geographically spread water sources and its treatment methods are sophisticated and imported with, for example, the French company Degremot designing the rapid pressure filters at the Santa Ana plant. Significantly, in many parts of the city, the system's users are international or directly serving international tourists.

SEDACusco slips between an integrated mode, the vestiges of a universal ideal and the national framework that allows in private finance and drives more monitoring, differentiation and, what van Vliet et al. call, partially fragmented grids. In practice, this fragmentation is more subtle, with the company making investment judgements based on the livelihoods between and within the city's municipalities, strengthening some fragments and neglecting others. This configuration reflects van Vliet et al.'s comments that a generally

assumed trend away from a 'universal' mode of provision actually gives way to complex coexisting public and private priorities (van Vliet et al. 2005):38.

Meanwhile, Manco Capac which started life as a community-built autonomous system with a single, remote source, has shifted to a piecemeal mode of organisation which now taps another subterranean source, has added a slow sand filter and expanded its ad hoc connections. Its piecemeal operation, however, is without any spare capacity, still responsive to demand but only in the sense that it has to lock off different patches of the network on a rotating supply schedule just to make sure everyone gets something. It is isolated from global links to the knowhow of NGOs or international finance and it has become isolated from the limited capacities of local government. The provider committee itself, once tied strongly to the inhabitants of the zone, is isolated from users and can no longer count on community labour to maintain the system. The committee's technical capacity is casual to the point of being slack. Users faced with this socio-technical isolation venture to other networks to purchase water marketed by entrepreneurs connected to the SEDACusco system.

Finally, the successful, autonomous system in Angostura is supported by the civil society NGO, Centro Guaman Poma de Ayala. This is an NGO with experience reaching from the city's historic centre to agricultural settlements far down the southern valley. Moreover, the organisation's main donors are based in van Vliet's native Netherlands and in Spain. This has also meant that the NGO's heads of department have attended training hundreds of miles away in Europe. The water infrastructure itself is highly localised with the community building the reservoir and laying the modest network of pipes.

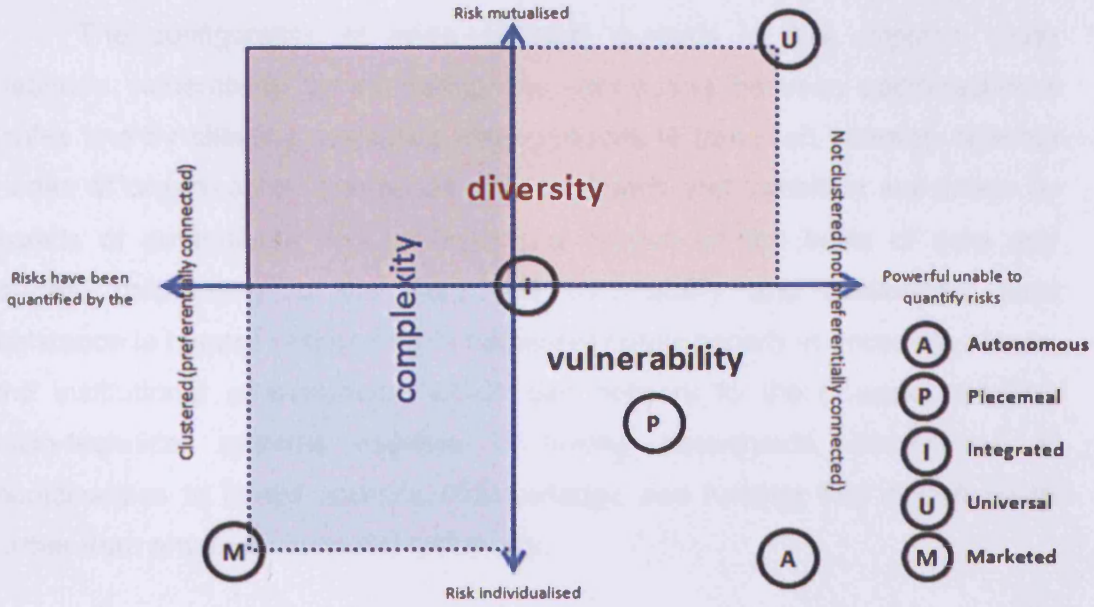
Angostura, which is bypassed by SEDACusco, has succeeded in expanding its drinking water and waste water infrastructure for three reasons. Firstly, these formerly bypassed places have made their own global connections to skills and finance through the civil society actor CGPdA. So far these links have fed into funding at the level of local government right through to technical training for the maintenance people, or *fontaneros,* on the ground.

Secondly, this civil society support has set up connections between municipalities. This has focused on interlinked economic and environmental issues in which many jurisdictions have a stake, from improving the quality of local agriculture and enhancing the amenity value of the southern valley to the integrated management of water.

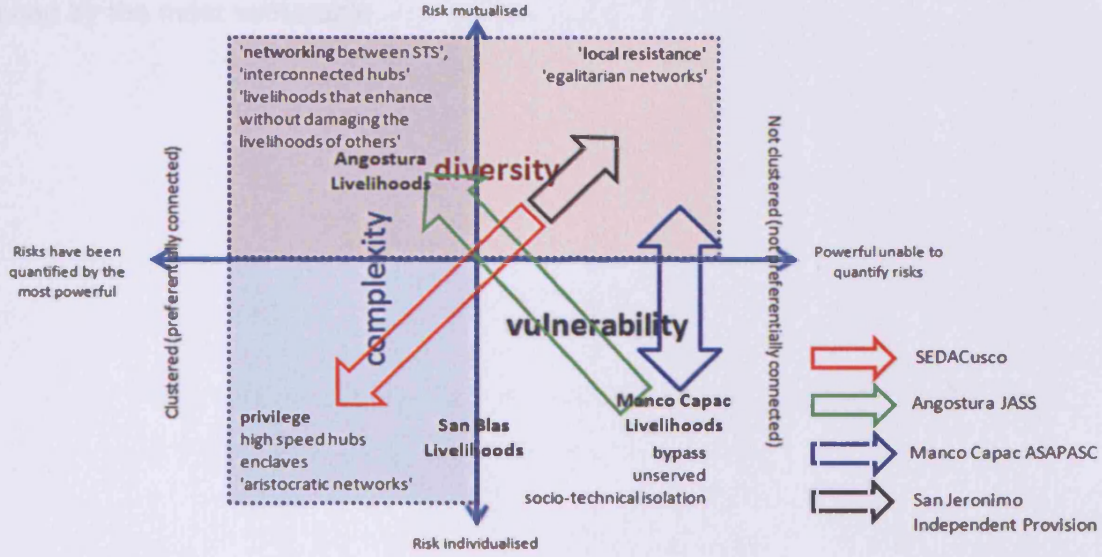
Formal structures for responding to these issues at municipal level now exist and their momentum is maintained through planning and, the third element of CGPdA's facilitation: citizen participation. This emphasis on local connections is a deliberate response to the experience of community organisations that have splintered internally by prioritising leaders and consolidating power. Although I have been reluctant to emphasise the benefits of community organisation to avoid lauding localism or assuming that such organisations always have the best interests of their constituency at heart, it is useful here to refer back to what Montgomery et al. call the community aspect of neighbourhood. For these authors, it only becomes important when 'spatially proximate individuals' are involved in 'social learning' and it is this that is being cultivated by CGPdA's intervention.

Following on from this categorisation of the modes of provision in the case studies and with reference to Chapter 2 and the mapping of van Vliet et al.'s modes onto the socio-technical space, as shown in Figure 92, I argue that socio-technical systems mediate between governance and vulnerability by shifting the groups of consumers and providers through which risk is shared. These shifts are processes of privilege, bypass, local resistance and networking.

Figure 92 Socio-technical conceptual space revisited: plotting van Vliet's modes of organisation (Crawford 2008)



Van Vliet et al.'s modes of organisation, although they are derived from and apply more comfortably to European (energy) infrastructures, emphasise three interesting aspects of infrastructure which have emerged in this study: interconnection between technical and social scales, which I call 'networking' and which describe the concepts of complexity and diversity; coexistence, which allows for incomplete splintering, local resistance and networking; and all these relationships shaping the services experienced by users, understood in terms of risk buffering and vulnerability. These features are shown in the framework below:



The configuration of socio-technical systems in this empirical study mediates vulnerability by stretching and connecting between socio-technical scales and by allowing coexisting arrangements to transition between different modes of organisation. The tendencies to stretch and transition are driven by models of governance that privilege and bypass on the basis of risks and returns, responding to the perceived vulnerability and livelihoods; local resistance to bypass responding to perceived heterogeneity in access to assets; and institutional arrangements which can network to the powerful creating socio-technical systems capable of linking households, committees or municipalities to useful sources of knowledge and funding that stretch much further than physical pipes and reservoirs.

I have argued that socio-technical systems mediate between governance and household vulnerability. My argument identifies three dominant

mechanisms which configure socio-technical systems in ways that determine how risk is shared: processes of bypass and privilege which pick out livelihoods and groups of livelihoods on the basis of risk; people, patches of infrastructure or jurisdictions stirring up local resistance; and institutions which knit together a network of different socio-technical scales. Just as these factors found their reflection in the sub-splinters of Manco Capac, so they are mirrored nationally and globally.

In the final chapter, I look at the broader implications for this work and what it means for achieving sustainable livelihoods and mitigating the risks faced by the most vulnerable.

Chapter 10 Socio-technical systems mediating between vulnerability and governance across Cusco

10.1 Closing the thesis

This final chapter draws together the contributions that this thesis makes to theory, methodology and policy. It also addresses the potential for implementing my findings and outlines the next research challenge raised by my work.

I begin with a final reflection on the picture of vulnerability and governance that has emerged from this study and the ways in which household risks are mediated through socio-technical systems.

I then comment on my contribution and what might follow.

10.1.1 Risk begets risk

Half way through last century, the structuralists', interpreted in Chapter 2 by Martinussen, proposed that an economy is not just about capital accumulation, production and consumption but that these activities are mediated by "hard, specific pieces" of equipment and groups of people. Rather than a system which continually found perfect, short-term equilibrium, the theoretical landscape of economics moved to an acknowledgement of the social and technological artefacts which held or stabilised certain conditions.

These ideas have also left traces on a globalisation discourse in which Martinussen's "hard, specific pieces" have morphed into the dynamic networks of Borja and Castells: networks which channel capital into a system of nodes at which investment is trapped for a while. For Borja and Castells, these networks tend to include the valued people and places all over the world while excluding what is devalued or undervalued and the networks persist as capital accumulates at city nodes and high-speed communication feeds these nodes with the information they need to stay ahead of the game and entrench themselves. Saskia Sassen sees, even within these prosperous nodes, a binary split between the high-end, financial sector and the low-wage services for which they create demand (Sassen 2001):10. In between the nodes, outside the networks, as wealth creates demand for products that only the rich can supply, economic growth might push up demand for what unskilled labour can produce but, in the context of globalised access to cheap labour, wages for the unskilled at best stagnate and, at worst, fluctuate wildly around an already low mean.

This in turn finds resonance in the discourse of modes of organisation and splintering urbanism which recognise the inertia of physical assets and the

patchy results of aspiring to universalise them on one hand and market them on the other. We saw examples in urban service provision of ambiguous and unorthodox co-production that persisted and continued to emerge despite efforts by the institutions of governance to standardise and modernise (Joshi & Moore 2004):44(Kaika & Swyngedouw 2000):136. Another example extrapolated the model of marketed organisation to argue for decentralised but interconnected infrastructure that, like Robert Chambers' complexity in livelihoods, would buffer the risk of system failures through self-organisation, local autonomy combined with far reaching interconnection to create redundancy in the system (van Timmeren et al. 2004):6.

Finally, the analogue for the sustainable livelihoods framework is the idea that shocks and stresses, like environmental hazards, inflation or recession, can be weathered by building up something fixed. Through a lens focused on the strategies of poor households, the hard pieces and skills are conceived as a portfolio of assets: financial, human, physical, natural and social. Indeed, the idea that a loose network might be pinned down into a household asset like social capital was summed up by Montgomery et al. when they distinguished a 'capital' from a network by explaining that the former emphasises the "more durable features of networks" (Montgomery et al. 2004):41. The more stable the network, the more useful as an asset but the less easily reconfigured, even if it is unfair or exclusive.

These conceptions of economies, global cities, infrastructures and households all have systems coalescing, stabilising and reinventing themselves better to respond to change. The sustainable livelihoods framework, in particular when it is conceived by Robert Chambers, borrows from the language and theory of complex systems and financial models, talking about these changes in terms of buffering vulnerability. Risk is spread, on this view, through diversity of livelihood activities and complex interactions between livelihoods which build a certain shock-smoothing redundancy into systems of livelihoods.

As with Chambers' positive ideas about diversity, the complex interactions that he thinks can combine to enhance livelihoods are also confounded by the reaction of service providers to riskiness in Cusco. Generally, where risk is not known it is prejudged, assumed and even estimated forward by financial markets and it is partly this aspect of private sector involvement in infrastructure that picks out safe or profitable nodes, sits behind Estache et al.'s

"secondary distributional effects" (Estache et al. 2001):1180 and shapes the economic, political and sociocultural processes of the World Bank which cause inequalities to "combine, interact" and reproduce themselves (World Bank 2006a):28.

However, investment in urban infrastructure is an interesting place for discrimination on the grounds of risk to unfold because, as Richard Batley observes, the dynamic and marginalised are juxtaposed (Batley 1997):339. In this context, the processes of privilege and bypass have two characteristics. Firstly, the injustice of these processes, with respect to damaging rather than enhancing the livelihoods of the bypassed, is often overt. There is optimism here about the possible collective reaction to risks that affect the livelihoods of the rich and the poor. Batley thinks that urban economic 'winners' will only be persuaded to petition change when they are facing critical political instability, environmental degradation or when the city becomes unattractive to investors (Batley 1997):345 a situation where risk is leaking into the privileged enclaves and coalitions of poor and non-poor are provoked.

Secondly, those affected by bypass and privilege in cities are both proximate and numerous. From here, Batley asserts that local agents can also drive change (Batley 1997):341. Certainly, in Cusco, bypassed for years by a national agenda devised in the capital, Lima, this local response is exemplified by the leadership of Daniel Estrada who made strident efforts to network globally by capturing tourist revenue in local coffers; reconfiguring the infrastructure of local markets; and buffering the livelihoods of the most vulnerable with programmes of direct assistance.

Similarly, Cusco's contemporary, internal response is concentrated where environmental degradation and socio-technical separatism are strongest: in municipalities that sense overt bypass like San Jeronimo; and where contamination and flooding (Angostura) or overcrowding (San Blas) have drawn in the support of an internationally supported, local civil society actor.

In Manco Capac where the socio-technical separatism of the late eighties has given way to isolation, however, the local response is muted and this sounds a warning note for a solution to the provision of urban services that relies wholly on civil society actors.

The idealised and normative good governance model that has the state, civil society and markets working harmoniously, or at least cooperatively, makes,

as we saw in Chapter 2, all sorts of assumptions about the motivations and capacities of each actor and, if we go back to Jenny Pearce's assessment of NGOs in civil society, we also find a story of fragmentation. As Pearce sees it, only projects that are deemed technically efficient will attract funding and this drives NGO aversion to processes, including participation, that are risky, messy or time consuming, again mirroring the splintering process. This is pause for thought given that so much that has supported the bypassed settlements in Cusco has until now emerged from civil society and, in particular, an NGO which sees the timescale for change as at least a decade or more.

Robert Chambers sees this process more broadly as one through which development professionals from the private, public and civil society sectors, crave and hoard information better to standardise and coordinate matters from the world's cores and hubs.

Meanwhile, with global markets responding by turns to sentiment, experience and shocks, their influence on governance can be volatile. The high-speed telecommunications and capital accumulation that drive Borja and Castells' global networks start by buffering this volatility but go on to embed a model of mitigation that actually reduces the possibility to mutualise risk over time: reinforcing Robert Tressel's "great barriers and ramparts" by favouring the low risks and high returns offered by people and things that are already successfully buffering vulnerability.

By dint of their extent and exclusive configuration, then, these governance systems are not good at understanding local circumstances and are more likely to ratchet up estimates of risk and play safe where information is poor or the context is precarious.

All this confirms a tendency to drive governments and civil society into the bottom left quadrant of the vulnerability model where the market is already happily ensconced. As we saw in Chapter 9, governance of infrastructure follows a similar pattern and, recognising this tendency to centralise and connect preferentially to other well connected hubs, van Timmeren et al. propose a risk-buffering approach which strengthens weak connections and forges links between unwieldy, centralised infrastructure and more nimble, autonomous systems. This model is also reflected in Chambers' plea for complexity and diversity in livelihoods and in the insurance analogy which

argues that people can only buffer shocks by networking with others who are subject to different, idiosyncratic risks.

Governance as both a framework for analysis and a tripartite prescription for development must examine the patterns that interconnect and fortify the most powerful. This thesis argues that households face risks to their livelihoods that are differentiated by their access to assets, infrastructure and influence. Splintering configurations of water and sanitation infrastructure are a response to the governance imperatives of providers and their perceptions of livelihoods but they also tend to interact with household vulnerability to amplify risk for those least able to buffer it. The potential for urban households to mitigate risk in a sustainable way is undermined by socio-technical isolation, weak assets and homogeneity in vulnerability. This potential is enhanced where assets are strong or vulnerability is mixed but also where socio-technical infrastructures stretch and connect people to knowledge, environmental assets and networks of users and providers; citizens and governance structures; and contaminators and contaminated.

10.1.2 A Contribution to Knowledge

The theoretical contribution of this thesis has been to develop an enhanced understanding of the relationship between vulnerability, governance and the socio-technical infrastructures that mediate between them.

The sustainable livelihoods framework already conceptualises an important connection between infrastructure and vulnerability context but these links are usually understood in terms of livelihood assets, part of the bundle of capitals within the household, and access to services, the presence or absence of a connection.

Socio-technical systems offer a way of conceptualising the links between household assets, infrastructure and environmental systems beyond households. A socio-technical systems approach takes in the geographic and historic dimensions of infrastructure: this is critical since the location of water pipes with a shelf-life of 25 years will affect livelihoods for a generation.

Policies, institutions and processes also feature prominently in the livelihoods framework and I deal with this component of the framework through

an analysis of national, local and water governance in Peru. The deliberate limitation of the governance framework is that it does not take account of the powerful embedded physical, institutional and environmental systems that mediate development. Even proponents of the framework recognise that the world's biases and injustices just seem to repeat and reproduce themselves and resist policy: governance is not able to explain all development outcomes with recourse only to the actions of frustrated governments, imperfect markets and whimsical civil society.

Socio-technical systems offer a way of introducing infrastructure as an additional actor in development, an actor that may constrain or allow certain social and economic trajectories.

Finally, I develop a model of socio-technical space during the thesis, both through a critical examination of the literature and a detailed empirical study. My framework allows modes of infrastructure organisation to be seen both in terms of vulnerability and the actions of the powerful: the socio-technical system is the group through which risk is shared. Certain system configurations use knowledge of or assumptions about risk to discriminate further and further until risk is individualised, other modes force the vulnerable into systems which are unable to buffer aggregate risk and others, through political negotiation or ideological hangover, encourage risk sharing that is blind to the individual.

The theoretical contribution of this framework goes further than this study and can be applied to an analysis of financial services and sub-prime crises, utilities, supermarket loyalty schemes, pay-as-you-go mobile telephones or car insurance, health services or health insurance based on the genetic material of individuals. I will examine the policy implications of this in a moment.

The methodological approach of this thesis is to use the mixed qualitative, quantitative and triangulation techniques advocated by the sustainable livelihoods framework. This encourages the use of secondary sources, group meetings, household and key informant interviews to frame an analysis of livelihoods and governance.

In order better to understand the mediating role of infrastructure, I introduce into this set of tools the World Health Organisation's methods for evaluating community drinking water systems. The presentation of the case studies then uses visual and graphical devices to express household assets as

pentagons; sanitary risks as colour coded charts; and the water systems as colour coded flow diagrams. The coding incorporates a visual inspection of risk and the results of a rigorous, laboratory based water sampling regime.

It is this combined methodology applied to an empirical study of Cusco that allows me to link household risks to assets, assets to infrastructure systems and infrastructure systems to governance.

In terms of a contribution to policy, the theoretical and methodological approaches of the thesis have served to articulate the tension between building up a highly refined and atomised understanding of urban vulnerability as a basis for apportioning costs or distributing infrastructure and using more blurred and prejudiced assumptions about the riskiness of whole groups that allow costs to be unwittingly shared, sometimes in virtuous cycle of privilege and sometimes in a downward spiral of bypass.

Understanding, individualising and quantifying risk, if that is what we should do, is only the first part of the picture. Persuading groups to share risk and give up information about themselves in a climate of splintering urbanism, individual responsibility and contingency is the challenge of governance. Socio-technical infrastructures are the entities through which risk is shared and their configurations can be embedded to enhance or damage livelihoods. Risk can only be shared when it is willingly and knowingly networked across institutional actors, across splinters of infrastructure and across livelihoods. This means building a better understanding of vulnerability in collaboration with the people at risk, such that it will not allow powerful systems to further discriminate.

My view is that we are all aware of the surprising and sometimes frustrating ways that these systems mediate between governance and our daily lives. In the UK, for example, there is a fairly constant public debate about identity cards and data protection. Both in the UK context and as a policy-making tool for citizens and institutions in Cusco, this thesis offers a conceptual space for us to examine the way we provide and consume infrastructure and services. In using the model, we should ask where we are now, where we are going by default and where we would actually prefer to be.

Applied to urban services, for example, I would ask: is there an overarching legislative framework that is pushing us towards individualised risk; is this foreseen by our social contracts and constitutions; do we have systems in

place to avoid discrimination and the processes of privilege and bypass that work to give discrimination an endogenous life of its own; how can we explore vulnerability and make collective decisions about its mitigation; how can we stretch and interconnect our socio-technical systems to make sure that the livelihoods of the powerful do not damage but enhance the livelihoods of others?

From an individual perspective, and turning the questions to my community and my family, I would then ask how I find myself connected to these systems and to the livelihoods of others; what this might mean for the risks that my children face; and how I might act to reconfigure these systems.

Faced with a changing climate and volatile economy that will reorder the geography and nature of risk, these are critical questions for mitigating vulnerability and making sure that our livelihoods are moving towards sustainable modes.

As far as implementation of these findings is concerned, my view is that the framework should be used to identify the different modes of provision in cities. By working out where the weakest systems operate, what they are connected to and who is running them, it is possible to intervene to bolster the capacity of socio-technical groups to buffer risk. In the abstract this involves stretching and connecting these groups to new sources of knowledge and finance, incremental improvements to hardware and better institutions. In practice, this mirrors the approach of the Centro Guaman Poma de Ayala in Cusco with their long time horizon and capacity building for municipalities and watersheds, not just communities.

More importantly, implementation means identifying the systems that are best at buffering risk and examining how these systems will fare in the face of new risks, including the risk of frustration and fury among those excluded from safe enclaves.

Ultimately, implementation means promoting a more savvy and participatory negotiation of how risk is mutualised through our societies.

The next research challenge is to test the usefulness of a model of socio-technical space across different disciplines and phenomena. So far I have had interest from educationalists in the UK government who want a platform for mediating discussions with their quantitative counterparts in the treasury when

they analyse the implications of education policy. A colleague at UNDP has quizzed me on how it might apply to Yemeni water infrastructure where dominant mountain tribes are pumping water away from their valley dwelling rivals and the whole country is on the verge of extreme water scarcity. My examiners reflected on the socio-technical systems approach to a shift to a low carbon economy. An editor of the journal Revolutionary History has looked over it and taken a stab at placing various ideologies in the spaces. An academic from the US asked how the model would deal with an analysis of sub-prime, given that getting credit into the communities of the disconnected and bypassed seems to be desirable according to the framework but has ended in tears on the ground.

A second research challenge is a more sophisticated analysis of risk in the context of infrastructure distribution. Even if this quickly shows that what I have presented is merely a warped derivation of the risk modelling algorithms that underlie all our transactions, it should still expose the mechanisms for sharing risk which are configured around us. What the framework should do is take us further than labelling these arrangements as logical or natural or letting us lazily extrapolate all injustice from the inevitability of 'human nature'.

Word Count: 96,536 including footnotes

Appendix A Water Sector Structure

Figure 93 Before 1970 Responsibility for the water sector was centralised in the Ministry of Public Works. In 1970 urban and rural responsibility was split between ministries but still centralised. Several cities held on to independent local systems.

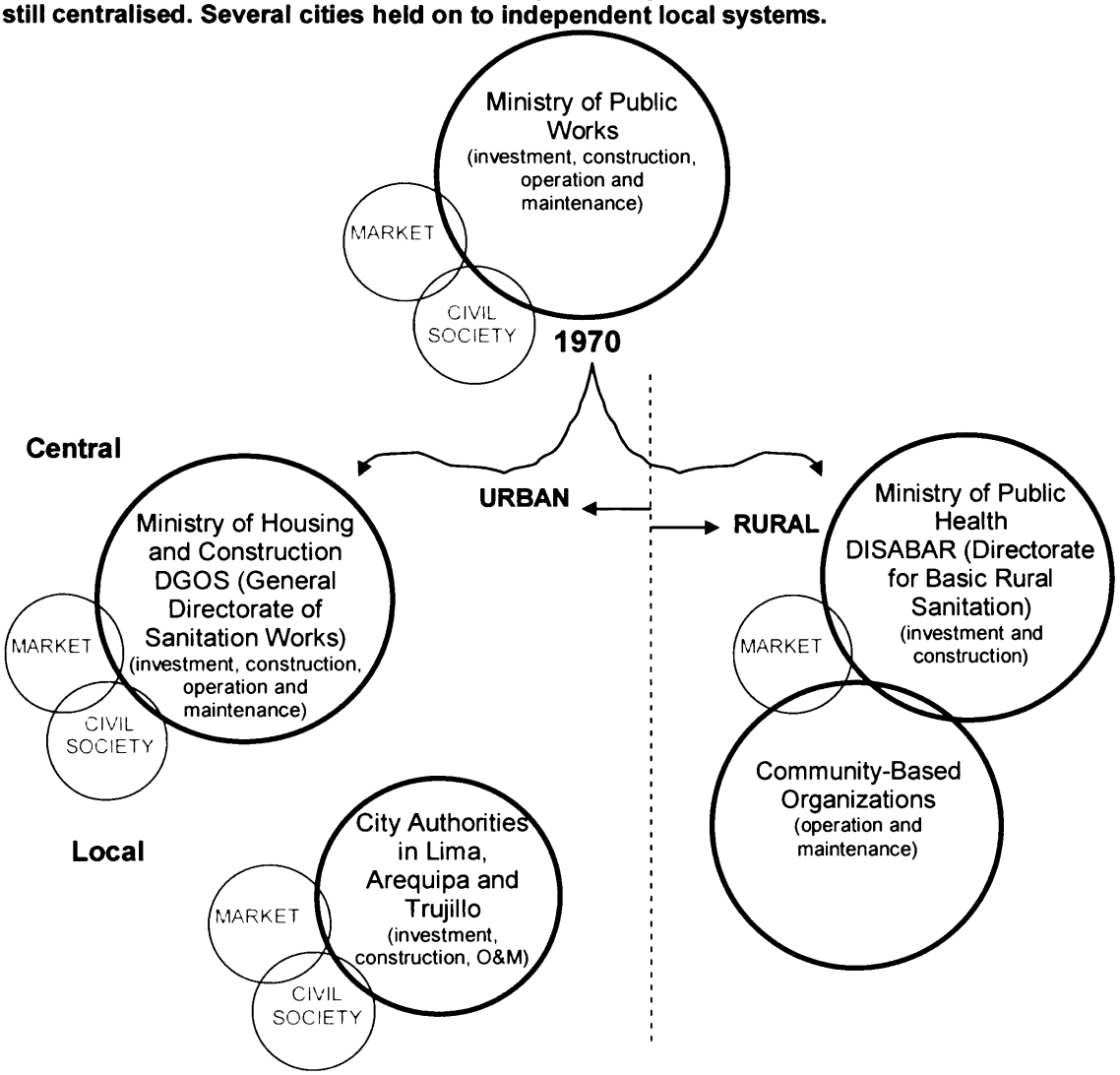


Figure 94 In 1981 responsibility for urban water and sanitation merged into a centralised state-owned holding company but this time 200 cities retained autonomous arrangements.

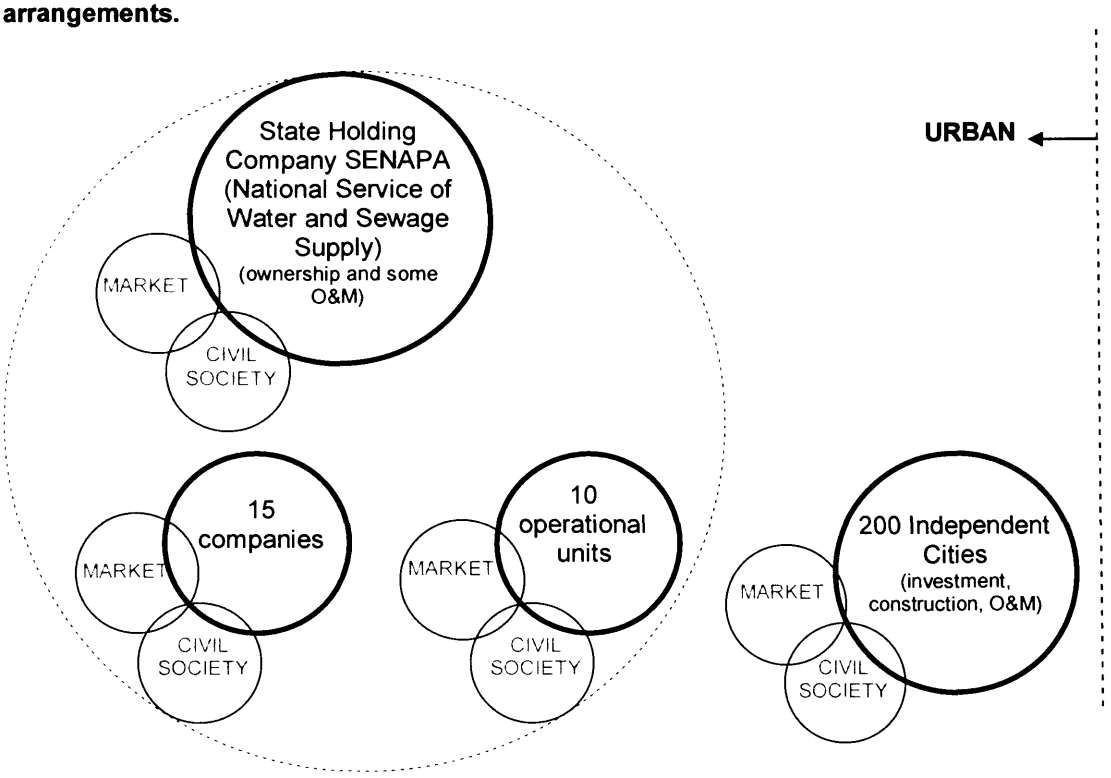


Figure 95 During the first half of 1990, the outgoing President Garcia attempts to hand urban responsibility for water to municipalities

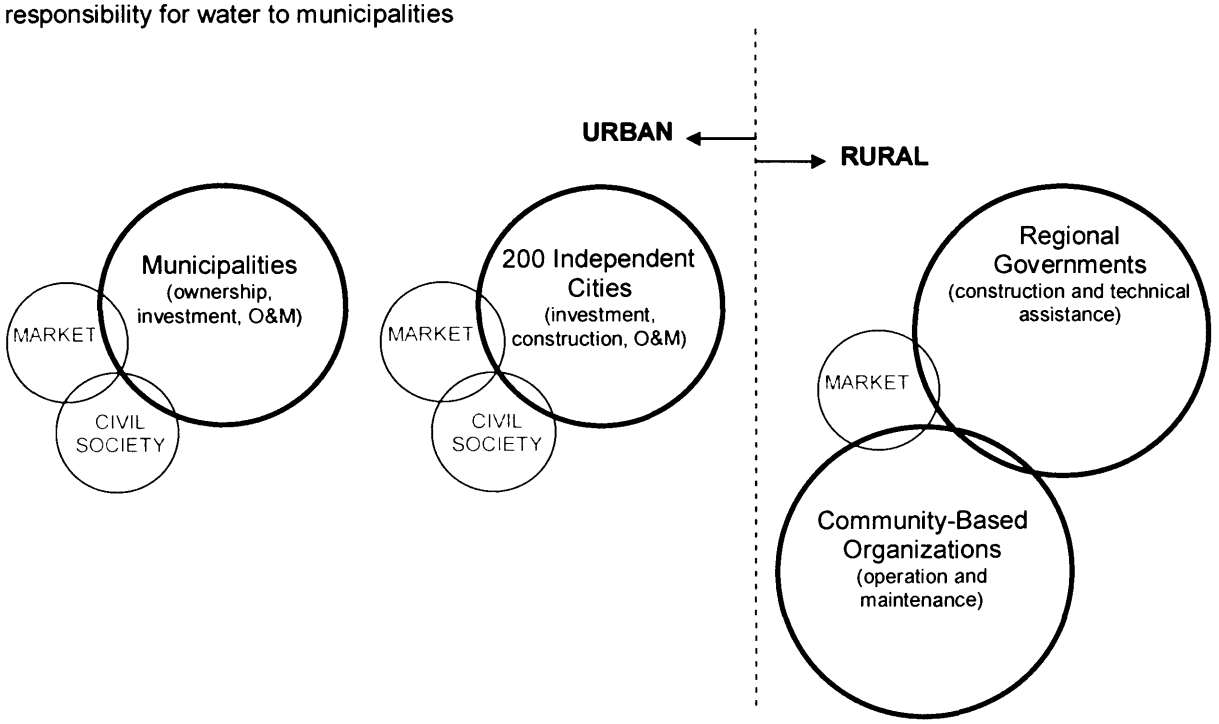


Figure 96 Second half of 1990: Incoming President Fujimori assumes centralised responsibility for water via the Ministry of the President

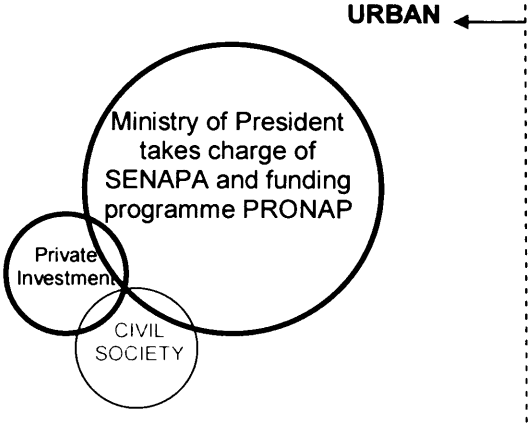


Figure 97 By1994 the legislation had made provisions for a regulatory body, SUNASS, public health policy in the Ministry of Health. In 2000, the picture was much the same except that the sector's governing body was not longer under direct presidential control.

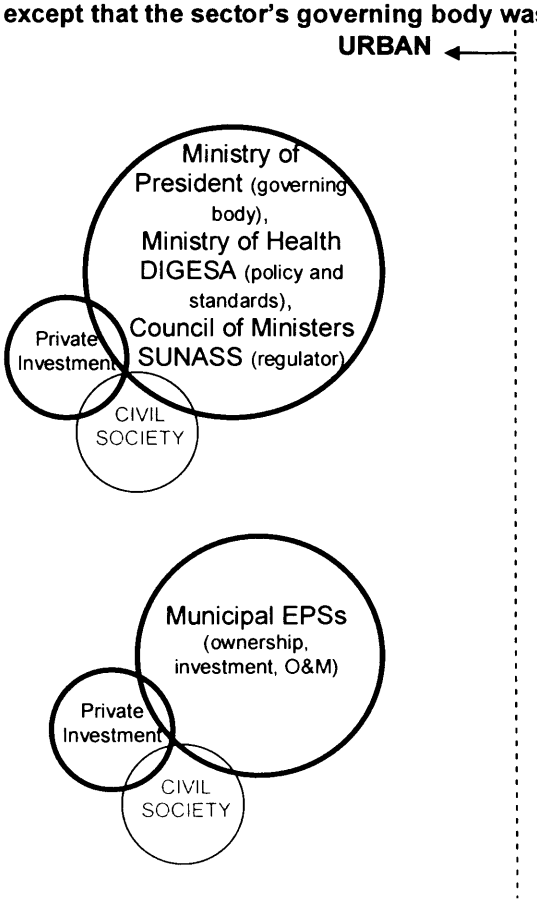


Figure 98 Rural governance

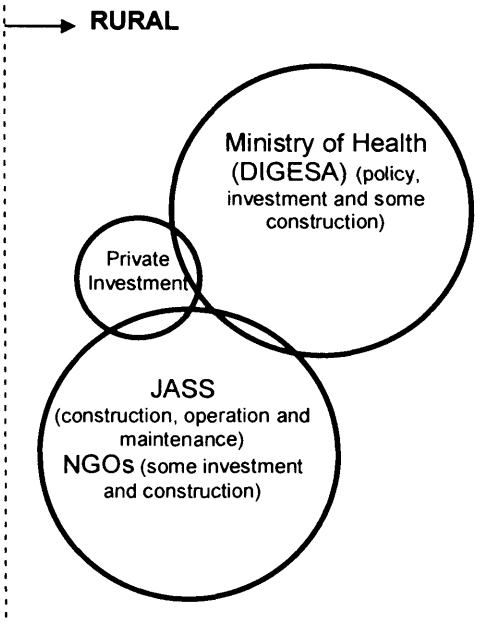


Figure 99 Model of governance with private investment in Tumbes in 2005

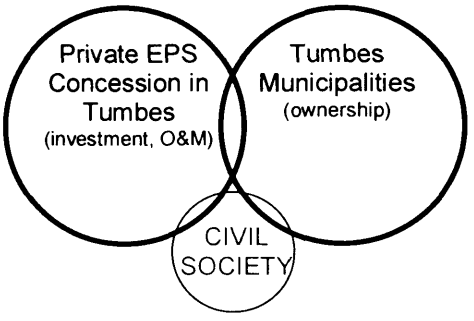


Figure 100 Idealised governance institutions

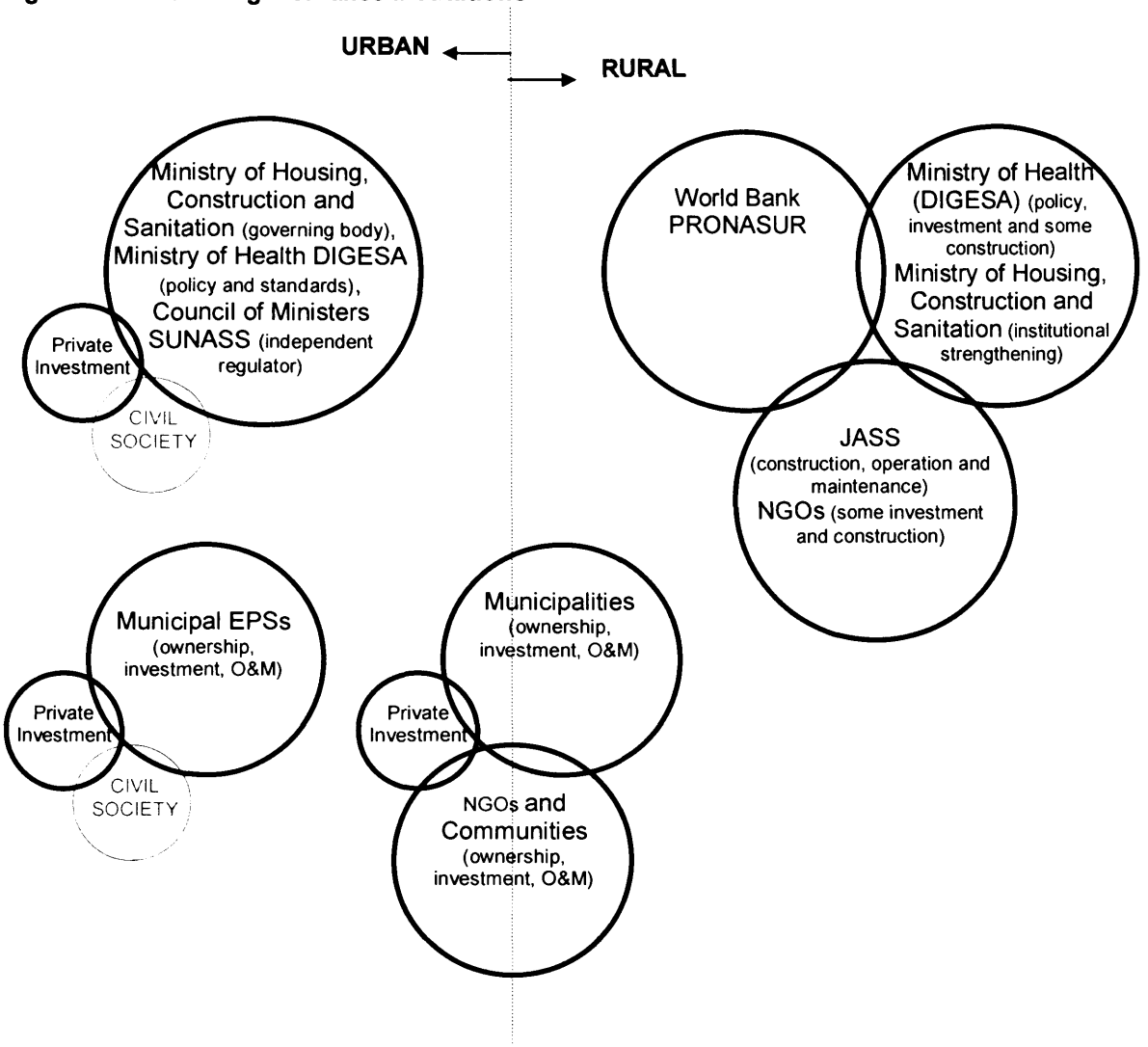
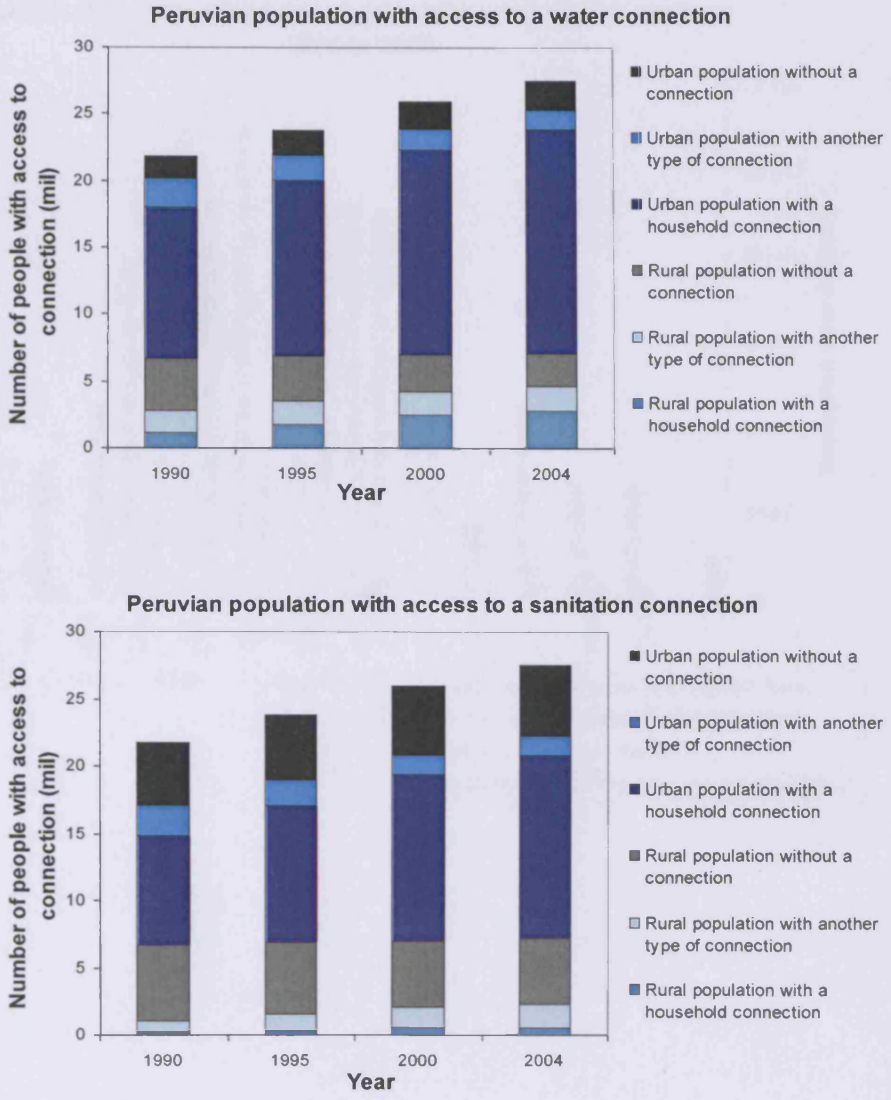


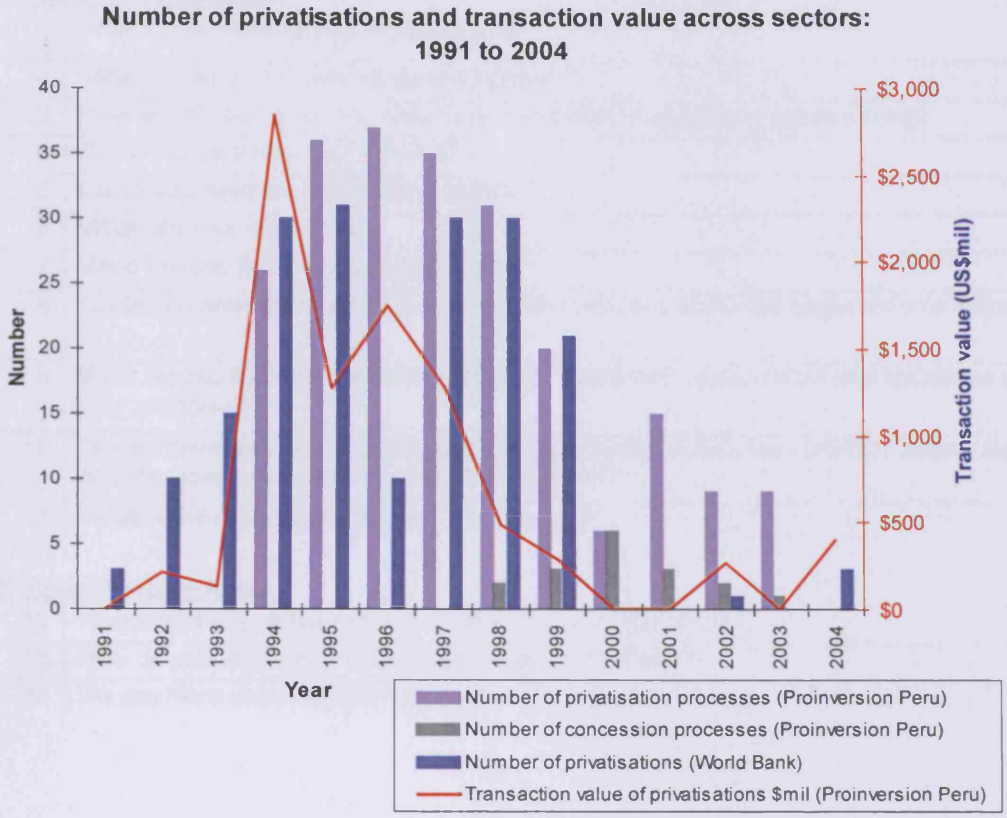
Figure 100 shows how this governance story translates to the number of people with access to a household connection for water and waste water. Overall water connections outnumber waste water connections but both have been increasing steadily since 1990.

Figure 101 Peruvian water and sanitation connections



Source: Datos Basicos de Cobertura en Agua Potable y Saneamiento para la Region de Las Americas, Organizacion Panamericana de la Salud http://www.cepis.ops-oms.org/AyS2004/paises/peru/peru.html

Figure 102 GDP and number of privatisations between 1991 and 2004 (World Bank 2006b)



Appendix B Key Informant Interview Format

B1 General Questions

1	What is the name of your organisation?
2	What is your organisation's governing body?
3	How would you define the regulatory framework in which you are operating?
4	Could you describe your mission?
5	Could you describe your main functions?
6	What are your objectives?
7	What are you main sources of funding?
8	Could you point be towards documents and archives about the organisation's history?
9	What do you think are the main strengths, weakness, opportunities and limitations of your organisation?
10	Do you have partners organisations form the health sector, the voluntary sector, civil society, government or other external agencies?
11	What is the organisation's long term strategy?

B2 Specific questions

12	How would you define your geographic area of operation?
13	How do you work with independent water committees?
14	Do you have documentation on XXX projects?

Appendix C Household Interview Format

C1 Spanish Version

HOGAR (REF.....) **FECHA:.....** **HORA:.....**

A1. para cada persona ¿qué relación de parentesco tiene con el jefe(a) del hogar? 0. Jefe(a). 1. Esposo(a) / Compañero(a). 2. Hijo(a). 3. Yerno / Nuera. 4. Nieto(a). 5. Padres / Suegros. 6. Otro(a) pariente. 7. Trabajador(a) del hogar. 8. Pensionista. 9. Otro(a); no pariente	A2.sexo	A3.edad	A4.¿cuál es el último nivel de estudios que aprobó? 0. Sin nivel 1. Educación inicial 2. Primaria incompleta 3. Primaria completa 4. Secundaria incompleta 5. Secundaria completa 6. Superior no univ. incompleta 7. Superior no univ. completa 8. Superior univ. incompleta 9. Superior univ. completa

A10.¿a qué tipo de trabajo se dedican? (Si tiene una chacra, la pregunta 12b) 0.obrero/a 1.jebaña 2.chacrero/a 3.abarrotero/a 4.tiene restaurante 5.ama de casa 6.profesional *eventual	A11. ¿esta persona trabaja fuera o dentro del hogar?	A12.¿sus ingresos son: 0. diarios? 1. semanales? 2. mensuales? 3. por cosecha?	A13.¿mas o menos, cuál es el ingreso diario, semanal, mensual o por cosecha?

A5. ¿su vivienda es:	
Alquilada	
propia: pagándola a plazos	
propia: totalmente pagada o de herencia	
propia por ocupación	

A6. Sin contar baño, cocina, pasadizos ¿cuántas habitaciones en total tiene la vivienda?	
A7. ¿cuántos para dormir?	

A8. ¿desde cuándo viven ustedes en éste barrio?	
A9. ¿desde cuándo viven ustedes en ésta vivienda?	

A14. ¿éstos ingresos cambian mucho durante el año?	
A15. ¿cómo?	

A10b. tienen tierras de cultivo:	
Alquiladas	
Propias	
A10c. ¿dónde están?	
dentro del distrito	
fuera del distrito	
Otro:	
A10d. ¿qué producen?	
A10e. ¿cómo riega la tierra?	

A16. ¿crían ustedes animales en la casa?	
A17. ¿para qué?	
para comer	
para vender	
para la seguridad	
como mascotas	
para erradicar ratones	
Otro:	

AGUA

B1. el abastecimiento de agua en su vivienda procede de:	
¿red pública, dentro de la vivienda?	
¿red pública,fuera de la vivienda, pero dentro del edificio?	
¿otro? (especifique)	

B2. ¿quién brinda el servicio de agua?

B3. ¿cuántos caños tiene?	
B4. ¿cuántos pierden agua?	
¿quién se ocupa de la reparación de las instalaciones?	
B5. ¿cuántas horas al día tiene agua?	
B6. ¿cuantos días a la semana?	
B7. Para usted, ¿por qué cree que no tiene agua el resto del tiempo?	
B8. ¿se abastece de otras fuentes a parte de su propio caño?	
B9. ¿cuáles?	

B10. ¿existen interrupciones irregulares en el servicio de agua potable?	
B11. ¿cuándo fue la ultima? (meses)	
B12. ¿en el transcurso del año cuántas interrupciones ha tenido? (veces por año)	
B13. En promedio, ¿de cuánta duración?	
B14. ¿qué hicieron ustedes?	
B15. ¿qué organizaciones les ayudaron?	

B16. para usted, ¿qué opina sobre el servicio de agua potable que tiene?	
B17. ¿usted o su familia ha tenido una enfermedad relacionada con el agua?	
B18. ¿qué tipo de enfermedad y cuándo y con qué frecuencia?	

B19. en los 5 últimos años, ¿el servicio de agua potable ha cambiado?	
B20. ¿cómo?	

HABITOS

B21. ¿para qué actividades usa el agua a parte de las siguientes: para beber, cocinar, lavarse, la limpieza y la lavandería familiar?	
lavandería (de a fuera de la vivienda)	
Animales	
cocinar (restaurante)	
producción de otra comida	
producción de adobe	
producción de otras materiales para la construcción	
otra:	

B22. ¿almacena agua en la casa?	
B23. ¿en qué?	
cilindro (con tapas)	
cilindro (sin tapas)	
baldes (con tapas)	
baldes (sin tapas)	
bidones pequeños "cuadrados"	
jarras (con tapas)	
jarras (sin tapas)	
ollas (con tapas)	
ollas (sin tapas)	
tanque diseñado para el almacenamiento del agua	
otro:	

B24. ¿cada recipiente es llenado todos los días?	

B25. ¿cómo llena usted los bidones?	
Directamente del caño	
usando otro recipiente	
usando una manguera	
Otro:	

B26. ¿cuántos bidones usan ustedes?	
Numéro de cilindros y capacidad aproximada	
numéro de baldes y capacidad aproximada	
numéro de bidones pequños "cuadrados" y capacidad aproximada	
numéro de ollas y capacidad aproximada	
numéro de otros recipientes y capacidad aproximada	

B27. ¿por cuánto tiempo almacena el agua, mas o menos?	

B28. ¿toma el agua:	
Directamente del cano?	
Directamente del bidon?	
hervida?	
Clorada en casa? (pregunta XX)	

B29. ¿cuándo clorar el agua?
B30. ¿cómo clorarlo?
pastillas
gotas
Otro
B31. ¿muéstreme?

B32. ¿tiene medidor para el agua?	
B33. ¿cuántos litros de agua cree usted que usa cada día, mas o menos?	

B34. ¿cuánto cobra el servicio de agua por mes?	
B35. ¿está de acuerdo?	
B36. ¿por qué?	

B37. ¿qué pasaría si no pagas?

B38. ¿podría ver la última factura?	
No tenemos facturas escritas	
Mes	
volumen	
tarifa	
Total	
Uso anterior	

B39. Si tuviera un problema con el agua potable, ¿ qué haría?

AGUAS SERVIDAS

C1. ¿el patio tiene drenaje de agua para la lluvia?	

C2. el servicio higiénico que tiene su vivienda está conectado a:	
¿red pública, dentro de la vivienda?	
¿red pública,fuera de la vivienda,pero dentro del edificio?	
¿pozo séptico, pozo ciego o negro / letrina?	
¿otro? (especifique)	

C3. ¿desde cuándo tuvo un servicio higiénico conectado así?	
C4. ¿quién lo hizo la instalación?	
C5. ¿quién ha pagado?	
C6. para usted ¿su desagüe desemboca:	
En el interceptor de SEDA	
En otro lugar: (especifique)	

C7. para usted, qué opina sobre el servicio de alcantarillado que tiene?

C8. En los 5 últimos años, ¿el servicio de alcantarillado ha cambiado?	
C9. ¿cómo?	

ENERGIA

E1. ¿cuál es el combustible que más se utiliza en el hogar para cocinar sus alimentos:	
Electricidad?	
Gas?	
Otro?	
E2. ¿quién le distribuye el gas (o otro)?	
E3. ¿cuántos balones de gas usan por mes?	
E4. ¿cuánto cuesta un balón de gas (tamaño - 6kg)?	
E5. ¿tiene medidor para la electricidad?	
E6. ¿cuánto ha pagado el mes pasado?	

E7. Si tuviera un problema con la corriente, ¿qué haría?

D1. ¿tiene un servicio para la recolección de basuras?	
D2. ¿por quién?	
D3. ¿dónde deja usted su basura?	
D4. para usted ¿cuál es el destino final de su basura?	
D5. ¿cuándo es la recolección? (día, hora)	
D6. ¿los caros de basura pasan por ésta calle?	
D7. ¿el servicio es adecuado?	
D8. ¿por qué?	

D9. Si tuviera un problema con la recolección de basura, ¿qué haría?

F1. ¿dónde está la escuela primaria más próxima? (lugar y tiempo para ir)	
F2. ¿dónde está la escuela secundaria más próxima? (lugar y tiempo para ir)	
F3. ¿dónde está el puesto de salud más próximo? (lugar y tiempo para ir)	
F4. ¿dónde está el paradero de colectivo más próximo? (lugar y tiempo para ir)	

F5. ¿qué ONG están trabajando en ésta zona?
F6. ¿cómo son?

F7. ¿participan en una organización comunal o del barrio?	
F8. ¿cómo se llama la organización?	
F9. ¿participa en las elecciones?	
F10. ¿paga una cuota?	
F11. ¿cuánto paga?	

F12. ¿van ustedes a las reuniones?	
F13. ¿por qué?	

F14. ¿ha participado en las elecciones de la JASS/ASAPASC?	
F15. ¿por qué?	
F16. Si tuviera un problema con la seguridad, ¿qué haría?	

RIESGOS

G1. ¿qué fenómenos naturales se presentan en su zona?	
G2. ¿cuándo fue el último? (meses)	
G3. ¿con qué frecuencia? (veces por año)	
G4. ¿qué hicieron ustedes?	
G5. ¿qué organizaciones les ayudaron?	

G6. ¿en éste lugar, hay apagones?	
G7. ¿cuándo fue el último? (meses)	
G8. ¿en el transcurso del año cuántos apagones ha tenido? (veces por año)	
en promedio, ¿de cuánta duración?	
G9. ¿qué hicieron ustedes?	
G10. ¿qué organizaciones les ayudaron?	

OBSERVACIONES

¿cuál es la superficie de la calle?	
asfaltada	
adoquinada	
tierra	
otra:	
¿hay pavimentos?	
¿es peatonal?	

El material predominante en: los techos es:	
concreto armado	
Madera	
Tejas	
planchas de calamina	
caña, estera, paja	

El material predominante en: las paredes exteriores es:	
ladrillo o bloque de cemento	
piedra o sillar con cal o cemento	
adobe o tapia	
piedra con barro	
quincha, madera, estera,	

El material predominante en: los pisos es	
parquet o madera pulida	
laminas asfalticas, vinilicos	
losetas, terazos	
Cemento	
Tierra	

evaluación de los riesgos sanitarios:	
El material predominante en: el patio es:	
Cemento sin desagüe	
Cemento con desagüe	
Tierra sin desagüe	
Tierra con desagüe	
Otra:	

El caño principal descarga en:	
Lavabo de concreto	
Lavabo de piedra	
El patio	
Otra:	

El caño principal es:	
Encastrado en el muro	
Una columna de alimentación	
Otra:	

El estado del caño principal es:				
Muy bien	Bien	Razonable	Pobre	malo

El estado de la manguera es:				
Muy bien	Bien	Razonable	Pobre	malo

Otras observaciones:

C2 English Version

GENERAL

A1. Starting with the head of household, what relationship does this person have to the head of household?

0. Head, 1. husband/wife/partners 2. child, 3. son/daughter-in-law, 4. grandchild, 5. parent/parent-in-law, 6. other relative, 7. working in house, 8. lodger, 9. other not related

A2. sex

A3. age

A4. what is your highest educational qualification?

0. sin nivel, 1. primaria completa, 2. secundaria completa, 3. superior tecnológico, 4. superior universitario

A5. is your house:

rented?, owned: paying mortgage? owned: no mortgage/mortgage paid? owned following invasion?

A6. Not counting the bathroom, kitchen and passages, how many rooms does it have?

A7. How many are for sleeping?

A8. How long have you lived in this house?

A9. How long have you lived in this neighbourhood?

A10. What does this person do for a living?

A10b do you have farmland?

do you own it, or rent it

A10c where is it?

Inside the district, outside the district, other

A10d what do you produce?

A10e how do you irrigate your land?

A11. Does this person work inside or outside the household?

A12. This person's income is:

0. daily, 1. weekly, 2. monthly, 3. by harvest

A13. approximately what is this income?

A14. do these earning change much during the year?

A15. how?

A16. do you rear animals in your house?

A17. what for?

to eat, to sell, for security, as pets, to control pests, other

WATER

B1. what kind of potable water connection do you have?

public network, connection inside house, public network, connection outside house but within building, Other:

B2. who provides your water service?

B3. How many taps do you have?

B4. Who does repairs on the installations?

B5. How many hours per day do you have water?

B6. How many days per week?

B7. Why do you think you don't have water the rest of the time?

B8. Do you use any other sources of water apart from your own tap?

B9. What sources?

B10. Are there irregular interruptions in the water service?

B11. When was the last one?

B12. During the year, how many interruptions are there?

B13. On average, how long do they last?

B14. What do you do?

B15. Do any organisations help you?

B16. What do you think of your water service?

B17 Have you or your family ever been sick from drinking the water?

B18. What type of illness?

B19. Has the water situation changed in the last 5 years?
B20. How?
B21. What is water used for apart from drinking, cooking and washing (family's clothes)?
washing (clothes for others), cleaning, animals, cooking (restaurant), production of other foodstuffs, production of adobe, production of other construction, materials, other:
B22. Do you store water in the house?
B23. In what? (note number and volume)
drums (covered), drums (uncovered), buckets (covered), buckets (uncovered), jerry cans, cooking pots (covered), cooking pots (uncovered), purpose built, storage tank, other:
B24. How many times a day do you fill your containers?
B25. How do you fill vessels?
directly from tap, using another container, using a hose, other:
B26. How many containers do you use?
no. drums (approx vol), no. buckets (approx vol), no. jerry cans (approx vol), no. cooking pots (approx vol), approx vol of storage tank, approx vol of other containers
B27. How long do you store water for? (hours)
B28. Do you drink water directly:
from the tap? from the storage container? boiled? chlorinated in your house?
B29. Do you chlorinate your water?
B30. How?
Tablets, Drops, Other
B31. Can you show me?
B32. Do you have a water meter?
B33. How much water do you think you use per day?
B34. How much is your monthly bill?
B35. Do you agree with the cost?
B36. Why?
B37. What happens if you don't pay?
B38. Could I see your last bill?
No printed bills, Month, Volume, Tariff, Total, Previous Use
B39. If you have a problem with the water supply, what do you do?

WASTE WATER

C1. Is there patio drainage for rainwater?
C2. what is your WC connected to?
public network connection inside house, public network connection outside house but within building
septic tank, latrine, other:
C3. How long has your WC had this sort of connection?
C4. Who installed the WC connection?
C5. who paid?
C6. Where does the waste water go?
Main drain (SEDA):, Somewhere else:
C7. What do you think of the waste water service?
C8. Has the waste water situation changed in the last 5 years?
C9. How?

ENERGY

E1. what is your main fuel source for cooking:
Electricity?, Gas?, Other?
E2. Who distributes this fuel?
E3. How many bottles of gas do you think you use per month?
E4. How much does gas cost (6kg bottle)?
E5. Do you have an electricity meter?
E6. How much do you pay for electricity?
E7. If you have a problem with electricity what do you do?

WASTE

D1. Do you have a waste collection service?
D2. Who provides this service?
D3. Where do you leave your waste?
D4. Where does your rubbish end up?
D5. When is the collection (day, hour)?
D6. can rubbish trucks come up this road>
D7. Is the service adequate?
D8. Why not?
D9. If you had a problem with the service, what would you do?

OTROS SERVICIOS

F1. Where is the nearest primary school? (place and time to get there)
F2. Where is the nearest secondary school? (place and time to get there)
F3. Where is the nearest health centre? (place and time to get there)
F4. Where is the nearest bus stop? (place and time to get there)
F5. Which NGOs are working in this are?
F6. What are they like?
F7. Do you belong to a community organisation?
F8. What's it called?
F9. Do you take part in the elections
F10. do you pay fees?
F11. how much do you pay?
F12. Do you go to the meetings?
F13 Why?
F14. Will you vote in ASAPASC/JASS elections?
F15. Why?
F16. If you have a problem with security what do you do?

RISKS

G1. what natural disasters affect you here?
G2. when was the last? (months)
G3. how often? (times per year)
G4. what did you do?
G5. what organisations help you helps you?
G6. Do you experience power cuts?
G7. when was the last? (months)
G8. how often? (times per year)
G9. what did you do?
G10. what organisations help you helps you?

MY OBSERVATIONS:
What is the road surface?
Sealed, Cobbled, Unsealed, other:
Are there pavements?
Is it pedestrianised?
Dominant material in roof:
Reinforced concrete, Wood, Tiles, CGI sheets, Thatch, reeds, Other
Dominant material in walls:
Brick or cement block, Stone with lime or cement, Mud brick, Stone with mud mortar, Wattle and dawb, wood, reeds
Dominant material in floors:
parquet or polished wood, tiles, vinyl, flagstones, cement, earth

Dominant material in patio:
Cement without drainage, Cement with drainage, Earth without drainage, Earth with drainage, Other

Main tap discharges in:
Concrete sink, Stone sink, Patio, Other

Main tap is:
Built in, Free standing tap, Other

Hose:
Very good, good, reasonable, poor, bad

Main tap:
Very good, good, reasonable, poor, bad

Appendix D Sanitation Checklists and Additional Results

D1 Water Systems

Table 35 Risk classification of sanitary scores

Sanitary risk score	Risk* Classification
0	No observed risk
1 to 3	Low risk
4 to 6	Intermediate risk
7 to 10	High risk

Table 36 Classification of thermotolerant coliform counts

TTC count	Colour Code	SB1***	A1	MC1	MC2
0	A		0		
1 to 10	B	<3 to 9 (66%)		2*	
10 to 100	C				
100 to 1000	D	<3 to 460 (34%)			
>1000	E				18000**

*MC1 in dry season, highest TTC count: 0
**MC2 in dry season, highest TTC count: 9
***TTC samples from rivers feeding Lake Piuray: 66% <3 to 9 NMP/100ml, 34% <3 to 460 NMP/100ml (PRONAMACHCS & INRENA 2005)

Checklist for a protected spring source (Angostura and Manco Capac)

		A1	MC1
1	Is the spring source unprotected by masonry or concrete wall or spring box and therefore open to surface contamination?	N	N
2	Is the masonry protecting the spring source faulty?	N	N
3	If there is a spring box, is there an unsanitary inspection cover in the masonry?	N	N
4	Is the area around the spring unfenced?	Y	Y
5	Can animals have access to within 10 m of the spring source?	Y	Y
6	Are there any latrines uphill of the spring?	N	Y
7	Is spring water combined with surface sources before treatment?	N	Y
8	If there is a filter, is it functioning badly?	N	Y
9	Is the flow uncontrolled?	Y	Y
10	Is chlorination unavailable or unreliable?	Y	Y
		4	**7**

Checklist for a surface source and community supply (Manco Capac) MC2

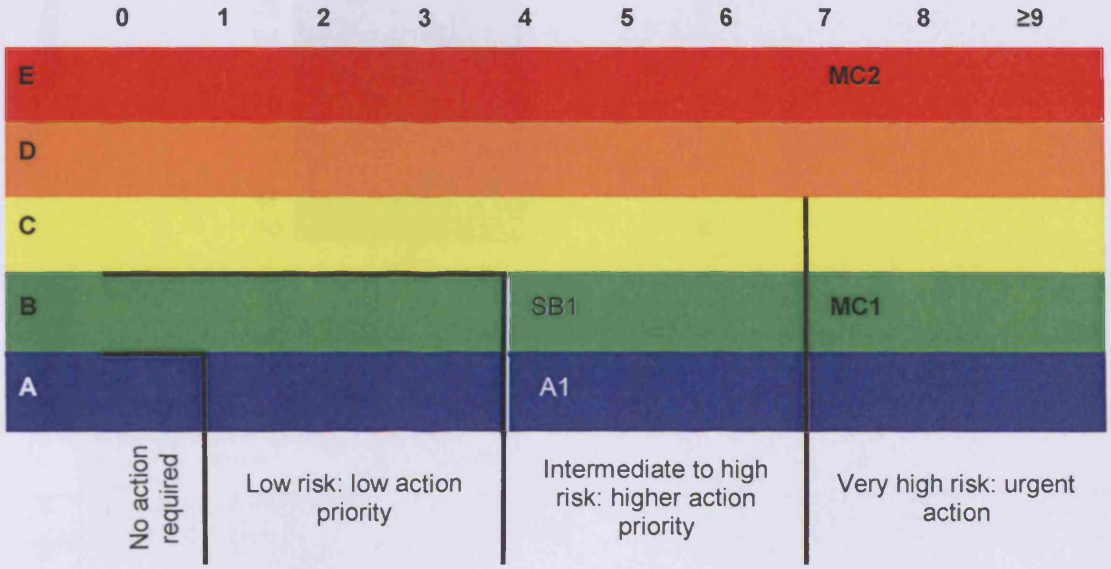
		MC2
1	Is there any human habitation upstream, polluting the source?	Y
2	Are there any farm animals upstream, polluting the source?	Y
3	Is there any crop production or industrial pollution upstream?	Y
4	Is there a risk of landslide or mudflow (causing deforestation) in the catchment area?	Y
5	Is the intake installation unfenced?	N
6	Is the intake unscreened?	N
7	Does the system require a sand or gravel filter?	N
8	If there is a filter, is it functioning badly?	Y
9	Is the flow uncontrolled?	Y
10	Is chlorination unavailable or unreliable?	Y
		7

Checklist for a surface source and municipal supply (San Blas)

		SB1
1	Is there any human habitation upstream, polluting the source?	Y
2	Are there any farm animals upstream, polluting the source?	Y
3	Is there any crop production or industrial pollution upstream?	Y
4	Is there a risk of landslide or mudflow (causing deforestation) in the catchment area?	Y
5	Is the intake installation unfenced?	N

6	Is the intake unscreened?	N
7	If the system requires pre-treatment, is it functioning badly?	N
8	If the system requires a treatment plant: is the plant functioning badly?	N
9	Is the flow uncontrolled?	N
10	Is chlorination unavailable or unreliable?	N
		4

Figure 103 Sanitary risk scores of all systems



D2 Household Connections

Location	Household	Max TTC count	Risk score
San Blas	16	0	3
	17	0	3
	18	1	4
	19	1	4
	22	1	0
	23	1	4
	24	0	3
	25	0	0
	26	1	4
	27	0	0
	28	2	4
	29	0	4
	30	4	4

	San Blas	16	17	18	19	22	23	24	25	26	27	28	29	30
1	Is supply intermittent?	1	1	1	1	0	1	1	0	1	0	1	1	1
2	Does tap discharge onto an undrained patio?	0	0	0	1	0	0	0	1	1	0	1	1	0
3	Is the only tap outside the house (but within the property)?	1	1	1	1		1		1	1			1	
4	Is the tap freestanding rather than built in to the wall?	1					1		1		1			
5	Is the tap in a poor condition? (leaking, cracked/eroded plinth, unsupported standpipe)													
6	Is water stored or collected?	1	1	1	1	0	1	1	0	1	0	1	1	1
7	Can contaminants (e.g. soil on the inside of the lid) enter the tank or container during filling?	1	1	1	1	0	1	1	0	1	0	1	1	1
8	Does the tank or container lack a cover?	0	0	1	0	0	1	0	0	0	0	0	0	1
9	Is there stagnant water around the storage tank or container?	0	0	0	1	0	0	0	0	1	0	1	1	0
10	Is the container is left uncleaned and undisinfected between fills?	1	1	1	1	0	1	1	0	1	0	1	1	1
	Household Risk Score	3	3	4	4	0	4	3	0	4	0	4	4	4

Location	Household	Max TTC count	Risk score
Angostura	1	1	3
	2	68	5
	3	4	0
	4	0	4
	5	5	4
	6	1	0
	7	0	0
	8	0	0
	9	142	0
	10	1	0
	11	1	0
	12	5	0
	13	255	0
	14	1	0
	15	0	5

	Angostura	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	Is supply intermittent?	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2	Does tap discharge onto an undrained patio?	0	1	1	1	1	0	1	0	1	0	0	0	0	0	1
3	Is the only tap outside the house (but within the property)?	1	1	1	1	1		1	1	1	1	1	1	1	1	1
4	Is the tap freestanding rather than built in to the wall?	1	1	1	1	1			1	1	1	1	1	1		1
5	Is the tap in a poor condition? (leaking, cracked/eroded plinth, unsupported standpipe)	1	1					1			1	1	1			
6	Is water stored or collected?	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1
7	Can contaminants (e.g. soil on the inside of the lid) enter the tank or container during filling?	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1
8	Does the tank or container lack a cover?	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
9	Is there stagnant water around the storage tank or container?	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1
10	Is the container is left uncleaned and undisinfected between fills?	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1
	Household Risk Score	3	5	0	4	4	0	0	0	0	0	0	0	0	0	5

Location	Household	Max TTC count	Risk score
Manco Capac	32	0	3
	33	275	3
	34	103	4
	35	556	4
	36	0	3
	37	438	4
	38	158	4
	39	72	3
	40	5	4
	41	1	3
	42	2	3
	43	17	4
	44	0	4

		32	33	34	35	36	37	38	39	40	41	42	43	44
1	Is supply intermittent?	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Does tap discharge onto an undrained patio?	0	0	0	0	0	1	0	0	1	0	0	0	0
3	Is the only tap outside the house (but within the property)?	1	1	1	1	1	1	1	1		1	1	1	1
4	Is the tap freestanding rather than built in to the wall?	1		1	1		1	1				1	1	1
5	Is the tap in a poor condition? (leaking, cracked/eroded plinth, unsupported standpipe)	1										1	1	
6	Is water stored or collected?	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Can contaminants (e.g. soil on the inside of the lid) enter the tank or container during filling?	1	1	1	1	1	1	1	1	1	1	1	1	1
8	Does the tank or container lack a cover?	1	0	1	1	0	0	1	0	0	0	0	1	1
9	Is there stagnant water around the storage tank or container?	0	0	0	0	0	1	0	0	1	0	0	0	0
10	Is the container is left uncleaned and undisinfected between fills?	0	1	1	1	1	1	1	1	1	1	1	1	1
	Household Risk Score	3	3	4	4	3	4	4	3	4	3	3	4	4

D3 Water Testing Methods

Thermotolerant coliforms per 100ml (TTCs) and residual chlorine are the key indicators for human health. The presence of TTCs indicates possible faecal contamination and the associated public health risk to humans. A residual level of chlorine at the last point in a distribution system is one indicator that disinfection is still effective.

Total Hardness (H) and pH, in the ranges measured in this fieldwork, are not implicated in human health but pH is important in water treatment since longer contact times for chlorination are required with higher pH levels.

The WHO offers no health based limit for Total Hardness but hardness above 200mg/l is known to cause furring in pipework. Hardness can affect the taste of drinking water, it does not rinse away soap as easily as softer water and it will also leave deposits on pots and pans. All these factors mean that public acceptability of hardness can vary.

TTCs, residual chlorine and pH were all determined using the standard methods and equipment provided with the Delagua water testing kit.

1. Thermotolerant coliforms: this method is taken from Section 5.4.4 of the Oxfam-Delagua Field Manual (Oxfam-Delagua 2004). Petri dishes were prepared by placing sterile absorbent pads in each dish and pouring in the pre-prepared, sterile sodium lauryl sulphate culture medium. The filtration apparatus was set up and sterile tweezers were used to place a sterile filter membrane onto the bronze disc filter of the apparatus. The filter funnel and collar were replaced and screwed down tightly then 100ml of sampled water were poured into the filter funnel. The plastic vacuum pump was connected to the filtration base and pumped in order to draw the water sample through the membrane. After removing the filter funnel, sterile tweezers were used to transfer the membrane to a pre-prepared Petri dish. The filtration apparatus was re-sterilized and the process repeated. After the final sample of the day a resuscitation period of 60minutes was scheduled before all the samples were placed in the incubator for 16hours at 44degreesC.

2. Residual chlorine and pH: this method is taken from Section 5.2 of the Oxfam-Delagua Kit Field Manual (Oxfam-Delagua 2004). Residual chlorine was measured using the colour comparators and adding DPD No 1 to read off levels of free chlorine residual and then adding DPD No 3 to this solution to read off total chlorine residual. pH was also measured using the colour comparator but this time with the standard indicator Phenol Red.

3. Total Hardness was measured using the standard complexometric titration method with EDTA as the titrant. Complexometric methods produce a colour change once titration is completed.

All these tests were carried out at the Coviduc laboratory by two lab assistants and me, when I was not in the field.

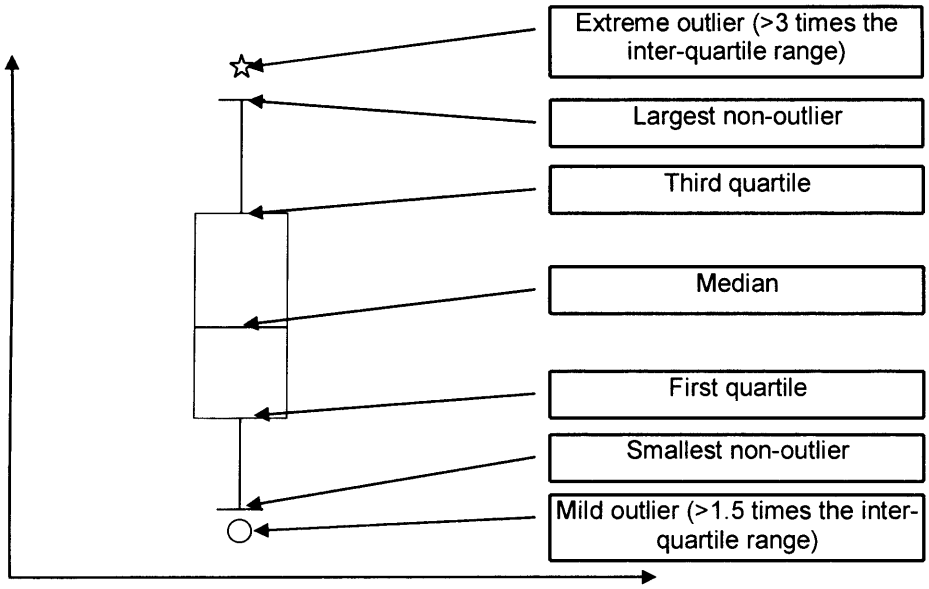
D4 Data Analysis and Descriptive Statistics

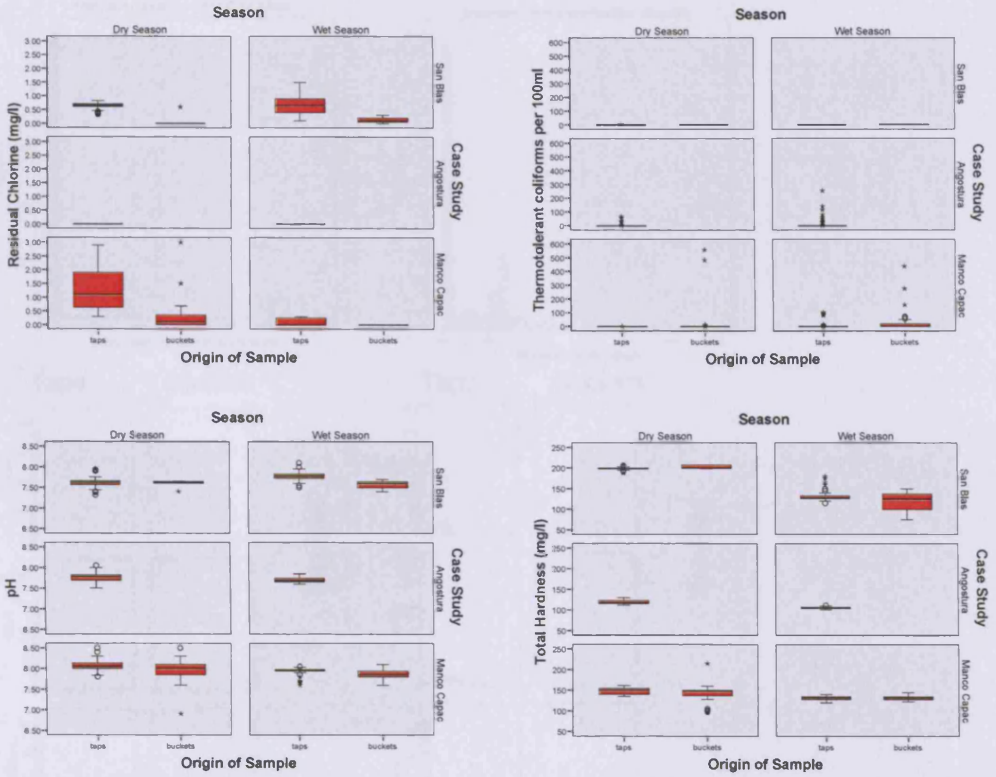
The data set was coded according the following convention and it was imported into SPSS.

Season	s	1=dry season, 2=wet season
Location	l	1=Angostura, 2=Manco Capac , 3=San Blas
Date	d	31st July 2006 to 6th February 2007
Day Number	day	1 to 39
Household	h	1 to 45
Time of Day	tod	1=morning, 2=midday, 3=afternoon
Origin of Sample	b	0=tap, 1=bucket
Sample Number	i	1=first, 2=second, 3=third, 4=fourth, 5=fifth

This appendix presents two data summaries: box plots for thermotolerant coliforms (TTCs), residual chlorine (RC), pH and hardness (H); and distribution histograms for the same indicators, disaggregated by location and whether the sample was direct from the tap or from stored water.

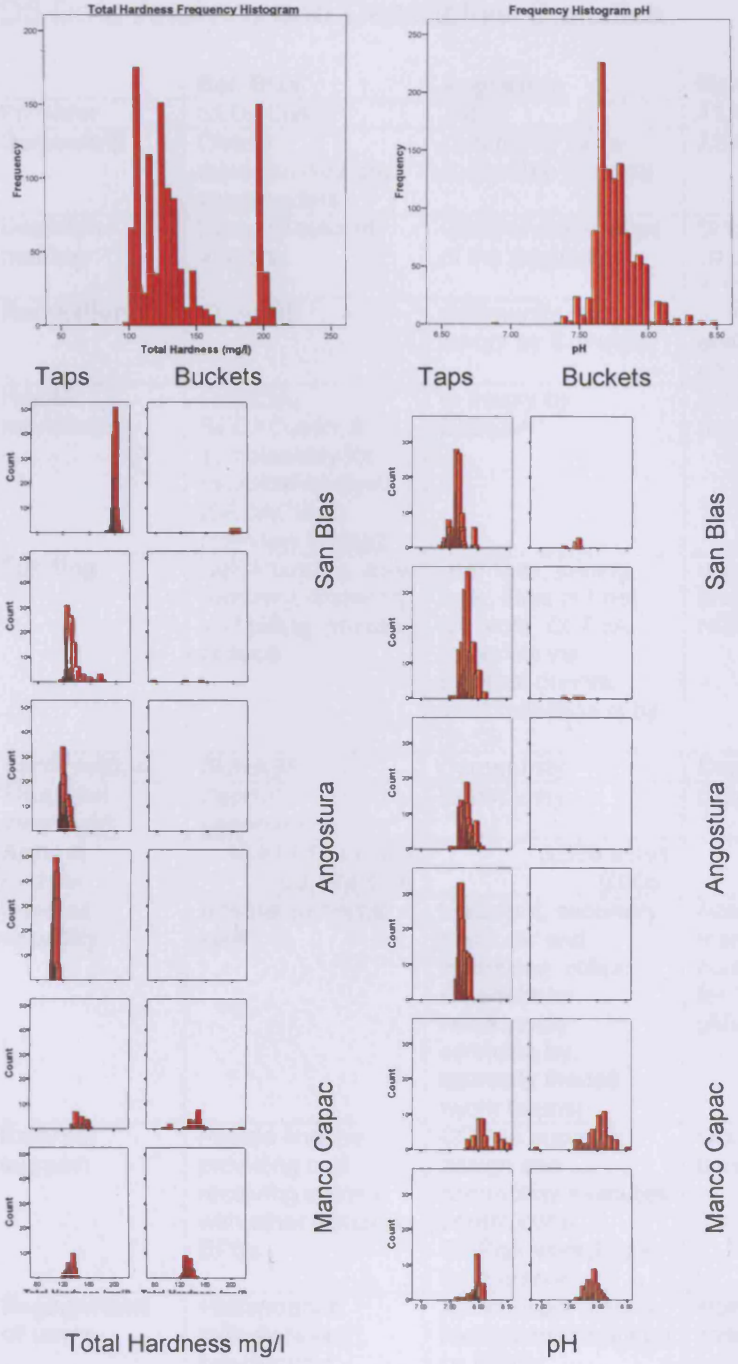
Box plots are useful to display differences between the case studies without making assumptions about underlying statistical distribution. The construction of the plot is as follows:





The frequency distributions below are presented to demonstrate the usefulness of box plots in describing the results. TTCs and RC are the key indicators. The distribution of TTC counts is highly positively skewed compared to pH and total hardness. pH and total hardness can be disaggregated by location to show the distributions in San Blas, Angostura and Manco Capac.


Frequency Histogram TTCs per 100ml
Frequency
Thermotolerant coliforms per 100ml
Frequency Histogram Residual Chlorine
Frequency
Residual Chlorine (mg/l)
Taps
Buckets
Taps
Buckets
San Blas
Angostura
Manco Capac
San Blas
Angostura
Manco Capac
Count
TTCs
Residual Chlorine mg/l


Total Hardness Frequency Histogram
Frequency
Total Hardness (mg/l)
Frequency Histogram pH
Frequency
pH
Taps
Buckets
Taps
Buckets
San Blas
Angostura
Manco Capac
San Blas
Angostura
Manco Capac
Count
Total Hardness mg/l
pH

D5 Data Analysis and Descriptive Statistics

	San Blas	Angostura	Manco Capac
Provider	SEDACusco	JASS	ASAPASC
Ownership	District municipalities are shareholders	community water committee or JASS	ASAPASC
Decision-making	board of elected mayors	General assemblies of the population	Board members (elected by each other) in theory a General Assembly
Regulation	SUNASS	community and in theory by SUNASS	In theory self-regulation, lawyer and accountant hired by committee
Health monitoring	DIGESA, SEDACusco: 8 samples/day for microbial analysis (SEDACusco Interview 3 2006)	In theory by DIGESA	in theory by DIGESA via health posts
Funding	Self-financing, cost recovery, metering and billing, private finance	user fees, joining fees, fines but not for profit, CGPdA materials via external donors, tariff collection is by JASS	user fees, connection fees and fines NGOs
Tariff setting	SUNASS	Community	Committee
Financial oversight	Central government	Community	Committee
Annual budget	18,411,903 soles (£3,162,589)	3,528 soles (£606)	177,780 soles (£30,546)
Internal capacity	Internal technical staff	president, secretary, treasurer and technician, rolling schedule for twice yearly servicing by quarterly *faenas* (work teams)	Administrator, 6 casual maintenance staff, contracted lawyer and accountant for "advice on transparency" (ASAPASC Meeting 2006)
External support	Private finance, providing and receiving training with other Peruvian EPSs	CGPdA supports design and community executes construction, CGPdA workshops for *fontaneros*	Occasional consultancy, Material donations by NGOs
Engagement of users	Performance indicators and benchmarks Adverts to promote water saving	assemblies, *faenas*, facilitation/promotion by NGOs	Poorly attended general assemblies
Number of connections	56,049	147	2,963
Jurisdiction	Provincial	Settlement	16 settlements
Geographic reach	Lake 22km away→flocculation, pressure filters, disinfection, storage, distribution via north main→pressure	5 springs, 62m3 reservoir, no treatment	Surface and spring source 9km away, filtration plant, reservoir 500m3, unpredictable manually operated chlorination

	zone San Blas		
System performance	703l/s (335l/s Piuray System) insufficient yield, population growth, production deficit disproportionately impacts the higher parts of the city, system losses, "crecimiento vertical"	5l/s lack of capacity, lack of funds, poor water quality, lack of monitoring, lack of regulation, lack of disinfection, old pipework, missing valves. rolling schedule for twice yearly servicing	14l/s Falling yield, agricultural activity in the catchment, pipes reaching end of 30 year life design life, uncontrolled post-treatment disinfection, fluctuating pressure, poor household connections, no maintenance schedule, 2 years: rehab of sand filters (depending on cash flow), 2 weeks: ad-hoc cleaning, 2-3 months: reservoir maintenance, lack of network drawings
Sanitary risk	Intermediate to high	Intermediate to high	Very high risk
Metering	Yes	No	No
Environmental linkages	Waste water system and discharge to River Saphy (underground tributary of Huatanay)	Waste water system, primary treatment and discharge to River Huatanay	Waste water system, no treatment, discharge to River Huatanay
Institutional linkages	Vilcanota Basin Mgmt Committee (IMA), GIHR (CPGdA)	Inter-district and GIHR	

Appendix E Glossary

E1 Spanish Terms

Ayllu	*Incan farming cooperative*
Campesino	*Peasant (with connotations of poverty)*
Chicha	*Local maize beer*
Chicharrón	*Pork scratchings*
Comedores Populares.	*Collective kitchens set up as part of nutrition programme*
Comunidad Campesina	*Peasant collective*
Cusqueño/a	*A person from Cusco*
El municipio	*Municipal territory*
Faena	*Community work days/teams*
Frente de Defensa	*Local political organisations created during the eighties to unite and solve the problems of the settlements*
Hacendados	*Landed or landowning class*
Hacienda	*Farm estate*
Junta directiva	*Board of directors*
La municipalidad	*Municipal government*
Los cabildos	*town councils*
Sendero luminoso	*Shining Path, Peruvian guerilla movement*
Tambos Comunales:	*Subsidised shops to deliver cheap basic foodstuffs*
Vaso de Leche	*Glass of milk government nutrition programme*

E2 Acronyms

AAHH	*Asentamientos Humanos*	*Human settlements*
APV	*Asociaciones Pro Viviendas*	*Housing cooperative*
ASAPASC	*Asociación de Servicios de Agua Potable y Alcantarillado de la Zona Sur Cusco*	*Drinking Water and Drainage Association of Cusco's Southern Zone*
CID	*Comité Inter distrital de Desarrollo*	*Inter-district committee for development*
DIGESA	*Dirección General de Salud Ambiental*	*Environmental health board*
EPS	*Entidad Prestadora de Servicios de Saneamiento*	*Water and sanitation company (provincial level)*
GIRH	*Gestión Integral de Recursos Hídricos*	*Integrated Water Resource Management*
IMA	*Instituto de Manejo de Agua y Medio Ambiente*	*Water and Environmental Management Institute*
ING	*Instituto Nacional Geografico*	*National Geographic Instititute*
JASS	*Junta Administradora de Servicios de Saneamiento*	*Administrative committee for water and sanitation*
PIDES	*Plan Integral de Desarrollo Estratégico y Sostenible*	*Integrated plan for strategic and sustainable development*
PPJJ	*Pueblos Jóvenes*	*Young towns*

S./ or sol.	*Nuevo Soles*	*Peruvian currency £1 = S./5.82 as at 28/09/06*
SEDA	*Servicio de Agua*	*Water service*
SERLIMP	*Servicio Limpieza*	*Street cleaning service*
SINAMOS	*Sistema Nacional de Movilización Social*	*National system for social mobilisation*
SUNASS	*Superintendencia Nacional de Servicios de Saneamiento*	*Water and sanitation sector watchdog*

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